LEVEL II

1

SUSQUEHANNA RIVER BASIN
COVEY CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

GLENWOOD LAKE DAM

NDI ID NO. PA-00327
DER ID NO. 35-143

PENNSYLVANIA DEPARTMENT OF GENERAL SERVICES (DGS)

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

Prepared by
Geo-Technical Services, Inc.
CONSULTING ENGINEERS & GEOLOGISTS
851 S. 19th Street
Harrisburg, Pennsylvania 17104

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JULY 1981

SUSQUEHANNA RIVER BASIN

COVEY CREEK, LACKAWANNA COUNTY

PENNSYLVANIA

GLENWOOD LAKE DAM

NDI ID NO. PA-00327
DER ID NO. 35-143

PENNSYLVANIA DEPARTMENT OF GENERAL SERVICES

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DACW31-81-C-0019

Prepared by

GEO-Technical Services, Inc.
Consulting Engineers & Geologists
851 S. 19th Street
Harrisburg, Pennsylvania 17104

For

Department of the Army
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

July 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND
RECOMMENDED ACTION

Name of Dam:	Glenwood Lake Dam NDI ID No. PA-00327 DER ID No. 35-143
Size:	Small (15 feet high; 76 acre-feet)
Hazard Classification:	High
Owner:	Pennsylvania Department of General Services (DGS) 2221 Forster Street Harrisburg, Pennsylvania 17125
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Covey Creek
Date of Inspection:	December 9, 1980

Based on visual inspection, past performance, field surveys and calculations, Glenwood Lake Dam is judged to be in poor condition. The recommended Spillway Design Flood (SDF) for the size (small) and hazard classification (high) of the dam is between the one-half Probable Maximum Flood (1/2 PMF) and the full PMF. Based on the small size and storage capacity, it is judged that the SDF of 1/2 PMF is appropriate for the Glenwood Lake Dam. Under the present conditions, the spillway will pass approximately 10 percent of the PMF without overtopping the dam. Overtopping depths of 1.1 feet and 2.12 feet were calculated for flood magnitudes of 20% and 50% of the PMF, respectively. It was judged that the dam will begin to fail under an overtopping depth of one-foot. Because the present spillway capacity would not pass the SDF without overtopping the dam and failure of the dam would increase the downstream hazard to life and property, the spillway is rated as seriously inadequate and the dam is rated as unsafe, non-emergency.

The facility is not properly maintained, as evidenced by the extensive growth of trees on the embankment and the condition of the outlet works valve pit.

→ to pg. iv

cont →

There is no warning system and evacuation plan in effect at the present time.

The following investigations and remedial measures are recommended for immediate implementation by the owner:

(1) Engage a Professional Engineer, experienced in the design and construction of dams, to perform additional hydrologic and hydraulic analysis to more accurately ascertain the present spillway capacity. As a result of the analysis, implement the necessary remedial measures to upgrade the present spillway capacity to the required Spillway Design Flood.

(2) Remove trees and brush from the crest and slopes of the embankment, under the supervision of a Professional Engineer. The trash inside the ice house foundation walls should be removed to avoid attracting rodents.

(3) Periodically measure the rate and clarity of the seepage at the toe of the dam and observe the condition of the unprotected upstream slope that is susceptible to erosion by wave action. Take appropriate action as necessary.

(4) Make necessary wall repairs at the outlet works valve pit, furnish a wheel for the upstream 8-inch gate valve and provide a hatch and lock to secure the facility against unauthorized operation of the valves. If there are no intake control facilities for the outlet pipe, such facilities should be provided to eliminate the constant reservoir pressure on the pipe.

In addition, it is recommended that the owner take the following precautionary operational and maintenance measures:

(1) Develop a detailed emergency operation procedure and warning system to facilitate timely and orderly evacuation of the downstream population if any hazardous conditions at the dam are observed.

(2) When warnings of a storm of major proportions are given by the National Weather Service, activate the emergency operating and warning system procedures.

(3) After satisfactory implementation of the remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a

GLENWOOD LAKE DAM

Professional Engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

Submitted by:

GEO-TECHNICAL SERVICES, INC.

GIDEON YACHIN, P.E.

Date: July 10, 1981

Approved by:

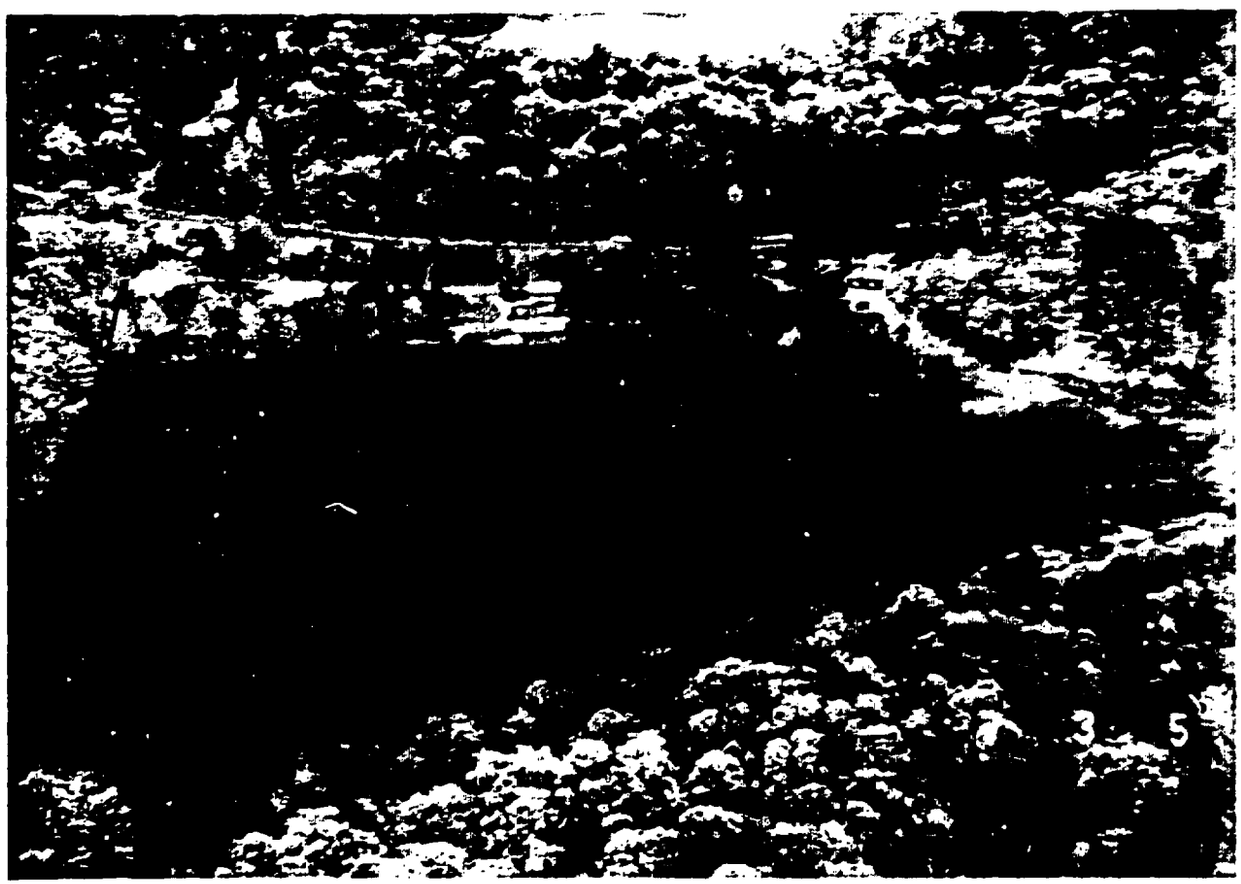
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS

JAMES W. PECK, COLONEL
CORPS OF ENGINEERS
COMMANDER AND DISTRICT ENGINEER

Date: 3 Aug 81

GLENWOOD LAKE DAM (PA - 00327)

(LAKE AREA & DOWNSTREAM RAILROAD FILL)
(SPILLWAY, SEE ARROW AT LEFT)



OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

GLENWOOD LAKE DAM
NDI# PA-00327, PENNDER # 35-143

SECTION 1
GENERAL INFORMATION

1.1 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.2 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.3 Description of Project.

a. Dam and Appurtenances. Glenwood Dam is an earthfill structure with a maximum height of 15 feet and a total length of 436 feet (excluding spillway). The right end of the dam terminates in an earth abutment. The left end of the dam terminates at a dry stone masonry wall on the right side of the spillway. The spillway is a 20-foot long broad crested concrete weir, 1-foot wide along its crest with a 1 on 5 upstream slope for 3.8 feet. On the downstream side, the spillway has a vertical drop of 0.4-foot to the excavated bedrock outlet channel. The bedrock channel extends about 50 feet downstream, dropping approximately 3 feet. Downstream of this, for a distance of 40 feet, the channel bottom contains large boulders that act as energy dissipators. The left wall of the spillway is steep excavated slopes, about 7 feet high, in hard massive sandstone. The outlet works consist of an 8-inch diameter cast iron pipe (CIP) controlled by two 8-inch diameter gate valves at the downstream end. The upstream valve had no control wheel and was open. The downstream valve was closed and its control wheel turned easily. The valves are enclosed in dry stone masonry and cinder block outlet structure (3.8'W x 10.2'L x 5.5'H) with an 8-inch concrete roof slab. Leakage through the walls and floor was about 1/4 GPM. This water discharged into an underground 18" CMP that terminates about 90 feet downstream in the natural stream channel (see Exhibit A-1, Appendix A). The intake facilities were underwater and their construction or condition could not be verified. The foundation walls of an old ice house built into the downstream slope on the right side of the dam are still standing. There is no evidence of any seepage or instability of these walls that could affect the safety of the dam.

b. Location: The dam is situated on Covey Creek, a branch of Spring Brook, in Moosic Borough, Lackawanna County, Pennsylvania. The dam's location is approximately 1.5 miles east of the intersection of U.S. Route 11 and PA Route 502. The dam is shown on the Avoca USGS 7.5 Minute Quadrangle Map at latitude 41°-20'-59" and longitude 75°-42'-15". A Location Map is shown in Exhibit E-1.

c. Size Classification: Small (15 feet high, 76-acre-feet).

d. Hazard Classification: High (see paragraph 3.1e).

e. Ownership: Pennsylvania Department of General Services (DGS) 2221 Forster Street, Harrisburg, Pennsylvania 17125.

f. Purpose of Dam: Recreation.

g. Design and Construction History: A local resident reports the dam was built about 50 years ago by the DeFazio family for harvesting of ice and later was used for recreation purposes by the DeFazio family. In the late 1970's, the dam and adjoining land was purchased by DGS for a proposed county prison site. There are no design or construction drawings and no records of inspection by any public agency until the present inspection.

h. Normal Operational Procedure: The pool is maintained at the spillway crest elevation with excess inflow discharging over the spillway into Covey Creek, a tributary of Spring Brook. The outlet works were closed on the day of the inspection and the downstream 8-inch gate valve operated easily. The location and construction of the intake facility for the outlet works were not visible and could not be verified.

1.4 Pertinent Data.

a. Drainage Area (Square Miles):	2.57
b. Discharge at Damsite (cfs):	
Maximum known flood at damsite	Unknown
Outlet works at minimum pool elevation	
Design	Unavailable
Computed	5
Spillway capacity, prior to overtopping	
Design	Unknown
Existing conditions	450
c. Elevation (feet above msl): See paragraph 3.1a for datum.	
Top of Dam	
Design Conditions (top of dam)	Unknown
Existing Conditions (lowest point)	759.2
Maximum Pool	
Design Conditions	Unknown
Existing Conditions	759.2

Elevation (feet above msl)	
Normal Pool (spillway crest)	754.6
Upstream Invert outlet works (underwater)	Unknown
Downstream Invert outlet works	744.2
Streambed at end of outlet drain	740.0
d. Reservoir Length (feet):	
Normal Pool	900
Maximum Pool	950
e. Storage (acre-feet):	
Maximum Pool	
Design Conditions	Unknown
Existing Conditions	76
f. Reservoir Surface (acres):	
Normal Pool	9.2
Maximum Pool	
Design Conditions	Unknown
Existing Conditions	15.5
g. Dam:	
Type	Earthfill
Length, excluding spillway (feet)	436
Maximum Height (feet)	
Design Conditions	Unknown
Existing Conditions	15
Top Width (feet)	
Design Conditions	Unknown
Existing Conditions	Varies 10 to 42
Side Slopes	
Upstream	
Design Conditions	Unknown
Existing Conditions	Vary 1.67H:1V to 2.0H:1V
Downstream	
Design Conditions	Unknown
Existing Conditions	Vary 1.64H:1V to 2.64H:1V
Zoning	Unknown
Cut-off	Unknown
Impervious Core	Unknown
Grout Curtain	Unknown
h. Diversion and Regulating Tunnel:	None
i. Spillway:	
Type	Uncontrolled broad crested, concrete weir with vertical 0.4' drop on excavated bedrock.
Length of Weir (feet)	20
Crest Elevation (feet above msl)	754.6
Upstream Channel in earth, length (feet)	13
Downstream Channel in bedrock, length (feet)	50

j. Outlet Works:

Type	8" dia. C.I.P
Length (feet)	Unknown
Closure and Regulating Facilities	
At upstream intake	Unknown
At downstream outlet	Two 8" gate valves
Structure	Dry stone & cinder block box (3.8'W x 10.2'L x 5.5'H)
Access	Opening in top of box (2.3'W x 2.5'L)

SECTION 2
ENGINEERING DATA

2.1 Design.

There is no available information relative to the design of the dam.

2.2 Construction Records.

There are no construction records. A local resident reported that the dam was built about 50 years ago.

2.3 Operation.

There are no records of operational history.

2.4 Other Investigations.

No other documented investigations were available for use in evaluating the dam.

2.5 Evaluation.

a. Availability of Data: There are no plans or other information available on the design and construction of the dam.

b. Adequacy: In the absence of design plans, specifications, or construction records, assessment of the dam and its safety must be based on the visual inspection and the hydrologic and hydraulic analysis presented in Section 5.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General: The overall appearance of the dam is very poor. The locations of observed deficiencies are shown on the General Plan presented in Exhibit A-1, Appendix A. The profile and typical sections of the dam are presented in Exhibits A-2, A-3, and A-4 and are based on field survey made on the day of the inspection (12-09-80). The survey datum for this inspection is elevation 754.6 feet above mean sea level, derived by interpolation of USGS contour lines for the low point on the spillway crest (see Exhibits E-1 and A-2). Deficiencies observed during the field inspection are described below, and are illustrated in Exhibit A-1, Appendix A. Visible features are depicted in photographs presented in Appendix C.

b. Dam: Observations made during the inspection indicate that the earth dam is in poor condition. Virtually the entire embankment is covered with brush and trees up to 18-inches in diameter, see photographs 1, 2, and 6, Appendix C. The upstream embankment slope varies from 1V:1.67H (1 Vertical on 1.67 Horizontal) to 1V:2H and has no riprap protection except for some intermittent riprap on the left 90 feet of the upstream slope. The top of the dam varies in width from 10 feet in the middle of the dam to 27 feet wide near the right abutment and 42 feet wide near the spillway dry stone wall (see Exhibit A-1). The elevations of the dam crest vary, as shown in Exhibit A-2, Appendix A. The lowest point on top of the dam is at elevation 759.2, or 0.2-foot lower than the top of the spillway wall. The downstream slope varies from 1V:1.64H to 1V:2.36H. A soft, wet seepage area, about 35 feet in diameter, is located immediately downstream of the dam between the valve pit and the spillway outlet channel. The total seepage was about 1/4 GPM (Gallons per Minute) on the inspection date and no accummulation of fine sediments was observed in the seepage area. The foundation walls of an old ice house are built into the right downstream slope of the dam (see photograph 1, Appendix C). The ice house walls contain an accummulation of trash (see photograph 1, Appendix C). There is no evidence of any displacement or leakage through the walls.

c. Appurtenant Structures:

(1) Spillway: The overall appearance of the spillway is good. The spillway is a broad crested concrete weir located on the left abutment. It is 20.0 feet long and 1.0-foot wide at its crest and has a 1V:5H upstream slope for a distance of 3.8 feet. It has a vertical drop of 0.4-foot on the downstream side. The right wall of the spillway is a dry stone masonry wall with a concrete cap. The wall is 2.5 feet wide and is 4.8 feet high at the weir (see photographs 3 and 4, Appendix C). The upstream end of this wall is flared to a 24-foot wide approach channel for a distance of about 13 feet. The left side of the spillway

and the outlet channel are excavated in hard massive sandstone for a distance of about 50 feet. In the next 40 feet downstream, the channel bottom contains large sandstone boulders that act as energy dissipators. Below this, the flow discharges into a natural wooded channel.

(2) Outlet Works: The intake facilities of the outlet works are under water and their construction or condition could not be verified. The outlet conduit is an 8-inch diameter cast iron pipe (CIP) with two 8-inch diameter gate valves. The upstream valve was open and its operating wheel was missing. The downstream valve turned easily to control discharge. Both valves near the downstream toe of the embankment are enclosed in a dry stone masonry structure. The structure is 3.8' wide by 10.2' long by 5.5' high, with a concrete top slab (8" thick) in fair condition. The downstream endwall at the structure is constructed with loose cinder blocks and the entrance cover plate is missing. The poor condition of this end of the outlet structure is shown in photographs 6 and 8, Appendix C. The valve pit structure is drained by an 18-inch corrugated metal pipe (CMP) that extends underground a distance of about 90 feet to the stream channel downstream of the spillway (see Exhibit A-1 and Photograph 7). About 1/4 GPM was leaking from the outlet structure side walls and floor.

d. Reservoir Area: The area surrounding the reservoir is gently sloped and wooded. There is no evidence of unstable slope conditions that would affect the safety of the dam. The upper reaches of the drainage area are wooded with slopes up to 25 percent and contain some coal stripped area. Two impoundments are located upstream of Glenwood Lake Dam (see Exhibit E-1); the Covey Swamp Dam (DER ID No. 35-43) and the Stark Dam (DER ID No. 35-41). Both dams are owned by the Pennsylvania Gas and Water Company. A field inspection (5-7-81) of Covey Swamp Dam revealed that its 10-foot high, 450-foot long earth embankment has been breached near its center. The trapezoidal breach is 37 feet wide at the top, 11 feet wide at the bottom and 10 feet deep. The spillway on the right abutment is a gently sloped trapezoidal channel 5 feet deep, 26 feet wide at the top and 5 to 6 feet wide at the bottom.

A field inspection of Stark Reservoir Dam revealed an earth embankment about 200 feet long and 20 feet high. The dam has 2H on 1V slopes, a top width of 7 to 8 feet and 2 feet of freeboard. A shallow, gently sloped spillway channel is located on the left abutment. The stone paved spillway has a depth of 2 feet below top of dam, a bottom width of 7.8 feet and a top width of 19 feet. The spillway was discharging about 300 GPM on the inspection date. The entire dam and spillway channel are covered with brush and trees. A 12-inch diameter cast iron pipe (CIP) outlet pipe and a 12-inch CIP supply pipe are located near the center of the dam. Both pipes are controlled by gate valves. About 1000 feet upstream of the dam on the right abutment, a lower level outfall channel discharges into a different drainage area. The trapezoidal channel has a bottom width 5.5 to 7.5 feet, a top width of 13 to 14 feet and is 3 feet deep. The channel bottom is 3 feet below spillway crest and 5 feet below top of dam. On the inspection date, the channel was

blocked by a beaver dam and only about 10 GPM was flowing in the channel. The water company uses the reservoir only as a reserve supply during emergencies.

e. Downstream Conditions: Downstream of the dam at a distance of about 250 feet is an access road culvert (4' Dia.), at 300 feet a railroad culvert (12.5' Dia.), at 900 feet a highway box culvert (6'H x 24'W) and at 1200 feet an access road box culvert (3.8'H x 10.7'W). About 200 feet left of these two box culverts is the Continental Cigar Company plant which employs about 70 people. Should the dam fail during working hours at the plant, more than a few lives could be lost and severe damages could occur. Consequently, Glenwood Lake Dam is classified as a high hazard structure.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The reservoir is maintained at normal pool level with excess inflow discharging over the spillway into the downstream channel. The downstream gate valve on the outlet pipe is kept closed.

4.2 Maintenance of Dam.

Maintenance of the dam by the present owner appears to be minimal and is considered unsatisfactory. There are no records of maintenance by previous owners. The entire dam is presently covered with brush and trees. Trash is being dumped inside the foundation walls of the old ice house built into the dam. The downstream wall of the outlet works structure is in disrepair and the entrance cover plate is missing.

4.3 Maintenance of Operating Facilities.

The intake facilities are underwater and their condition could not be verified. The downstream gate valve was in good operating condition.

4.4 Warning System in Effect.

There is no emergency operation and warning system in effect.

4.5 Evaluation.

The maintenance of the dam is inadequate. The trees and brush should be removed from the dam proper. The trash inside the ice house foundation walls should be removed to avoid attracting rodents. The downstream wall of the outlet structure should be repaired and the missing entrance cover plate should be replaced. The upstream slope of the dam should be protected with suitable riprap along the entire length of the dam. The owner should institute regularly scheduled maintenance inspections. Findings and subsequent maintenance and repair work should be documented. An emergency warning system is necessary to detect adverse conditions at the dam and to prevent loss of life should the dam fail.

SECTION 5
HYDROLOGY AND HYDRAULICS

5.1 Design Data.

There is no design information available for Glenwood Lake Dam.

5.2 Experience Data.

No records of prior flood stages or flows are available for Glenwood Lake Dam or Covey Creek.

5.3 Visual Observations.

Based on the visual inspection and field survey, described in Section 3 of this report, the observations relevant to hydrology and hydraulics are evaluated below:

a. Embankment: The present low point on top of the dam is at elevation 759.2, or 0.2-foot below the top elevation of the spillway endwalls. The overtopping analysis, presented in Appendix D, is based on the top of dam profile, shown in Exhibit A-2, Appendix A.

b. Spillway: The lowest point on the spillway crest is at elevation 754.6 on the right end of the spillway. Spillway discharge computations are based on critical depth at the spillway crest for the entire range of discharges. Under the prevailing top of dam elevation, the spillway discharge capacity is 450 cfs.

c. Outlet Works: Computations presented in Appendix D indicate that the capacity of the 18-inch diameter CMP is adequate to convey the discharges from the 8-inch diameter CIP, from the valve pit to the streambed of Covey Creek, without flooding the valve pit. At normal pool elevation and computed rate of flow through the outlet works is 5 cfs. The resulting exit velocity of 2.8 feet per second, at the outlet of the 18-inch diameter CMP, is not expected to cause detrimental erosion in the streambed.

d. Upstream Conditions: The storage effect of the two upstream reservoirs (see paragraph 3.1d) on the peak inflow discharges into Glenwood Lake was accounted for in the hydrologic and hydraulic analysis and is presented in Appendix D. Although the Covey Swamp Dam is breached, the trapezoidal breached section is relatively narrow and routing the flood flows through the breached dam was therefore included in the analysis.

e. Downstream Conditions: The effect of backwater from the railroad culvert, located 300 feet downstream of the dam, is evaluated in Appendix

D. The analysis indicates that the backwater resulting from flood flows of approximately 0.4 PMF would submerge the crest of the dam. For additional discussion of downstream conditions, see paragraph 3.1e.

5.4 Method of Analysis.

Hydrologic and hydraulic evaluation was made in accordance with the procedures and guidelines established by the U.S. Army Corps of Engineers, Baltimore District, Phase I Safety Inspection of Dams. The analysis has been performed utilizing the HEC-1DB program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. A brief description of program capabilities, as well as the input and output data used specifically for this analysis, is presented in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF): According to criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and the hazard potential (high) of the Glenwood Lake Dam is between one-half Probable Maximum Flood (1/2 PMF) and the full PMF. Based on the small size and storage capacity, the 1/2 PMF is the selected SDF for Glenwood Lake Dam.

b. Results of Analysis: The analysis indicated that under the prevailing top of dam elevations, the maximum capacity of the spillway is 450 cfs. This condition is equivalent to a flood magnitude of approximately 10% of the PMF. The peak inflow from the flood magnitude of the full PMF and 1/2 PMF are 6680 cfs and 3290 cfs, respectively. The dam is overtopped by 1.1 feet, 1.76 feet and 2.12 feet during peak outflow, resulting from flood magnitudes of 20%, 40% and 50% of the PMF, respectively. The duration of overtopping that corresponds to the aforementioned floods is 5.75, 9 and 9.25 hours, respectively. It was judged that the earth embankment cannot withstand an overtopping depth of more than one foot without failure. Breach analyses were conducted for the flood magnitudes of 0.2 PMF, the derived minimum flood that can cause dam failure, and for the flood magnitude of 1/2 PMF, the selected SDF. These analyses indicate that if the railroad embankment can withstand the dynamic forces resulting from the dam breach, the water surface at the downstream hazard area would be raised by 1.6 feet over the flood stage that existed just prior to the dam failure. Should the railroad embankment fail prior to the failure of the dam, the computed rise in the flood stage, downstream of the railroad embankment, is 3.6 feet. It is judged that the worst damage would occur if debris from the breaching of Glenwood Dam would block the railroad culvert, and subsequently cause the overtopping of the railroad embankment. All analyzed modes of failure raise the flood stages and the rate of flow downstream of the railroad embankment. These increases in flood stages constitute a serious hazard to property and loss of lives downstream of the dam.

5.6 Spillway Adequacy.

Because the present spillway capacity would not pass the SDF without overtopping the dam and failure of the dam would increase the downstream hazard to life and property, the spillway is rated as seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations.

The visual inspection of Glenwood Lake Dam is described in Section 3. Observations that are relevant to structural stability of the dam and the appurtenant structures are evaluated below:

a. Embankment: Field surveys indicate that the slopes of the dam are relatively steep in the vicinity of the outlet works (1.64H on 1V). There is no riprap protection on the upstream slope other than scattered riprap between the outlet works and the spillway wall. A small seepage (1/4 GPM) area is located below the downstream toe near the left end of the dam (see Exhibit A-1, Appendix A). The crest of the dam varies about 1-foot in height and the entire embankment is covered with brush and trees up to 18-inches in diameter. All of these conditions and deficiencies are of some concern; however, there is no evidence of structural instability of the dam. Remedial measures should be undertaken to correct the observed deficiencies.

b. Spillway: The concrete weir, the dry stone masonry wall and the excavated bedrock channel appear to be structurally sound and in fair condition.

c. Outlet Works: The 8-inch CIP outlet pipe and the 8-inch gate valve at the downstream end of the valve pit appear to be in fair condition. The valve did not leak and was easy to operate. The upstream 8-inch gate valve in the valve pit was open and its operating wheel was missing. The intake facilities are underwater and their construction or condition could not be evaluated. The dry stone walls and concrete roof of the outlet works structure were in fair condition. However, the downstream endwall, constructed of loose cinder blocks, is in very poor condition (see photographs 6 and 8, Appendix C); and the entrance cover plate was missing. The underground 18-inch CMP drain for the outlet structure appears to be in fair condition. The total leakage through the dry stone walls and floor of the intake structure is about 1/4 GPM and does not appear to be detrimental. Remedial measures should be undertaken to repair the downstream endwall and replace the entrance cover plate. The lake should be drawn down to inspect the intake facilities to determine if corrective measures are required. If there are no provisions to control the flow at the intake, such facilities should be provided. Upstream control of flow through the outlet works is required to avoid subjecting the entire length of the outlet pipe to the full reservoir pressure and to enable shutting off the flow should detrimental leakage develop.

6.2 Design and Construction Data.

There are no design or construction data available. Evaluation of the present structural stability of the dam is based on visual inspection.

6.3 Past Performance.

There are no available data, records or inspection reports relating to previous structural problems, overtopping or operation of the dam.

6.4 Seismic Stability.

The dam is located in Seismic Zone 1 and may be subject to minor dynamic forces induced by earthquakes. Normally, it can be considered that if a dam is stable under static loading conditions, it can be assumed safe for minor earthquake loading. Since Glenwood Lake Dam is assessed to be statically stable, it is assumed to be capable of resisting minor earthquake loads; however, no computations were made to evaluate this condition.

SECTION 7

ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety:

(1) Based on visual inspection, past performance, field surveys and calculations, Glenwood Lake Dam is judged to be in poor condition. The recommended Spillway Design Flood (SDF) for the size (small) and hazard classification (high) of the dam is between the one-half Probable Maximum Flood (1/2 PMF) and the full PMF. Based on the small size and storage capacity, it is judged that the SDF of 1/2 PMF is appropriate for the Glenwood Lake Dam. Under the present conditions, the spillway will pass approximately 10 percent of the PMF without overtopping the dam. Overtopping depths of 1.1 feet and 2.12 feet were calculated for flood magnitudes of 20% and 50% of the PMF, respectively. It was judged that the dam will begin to fail under an overtopping depth of one-foot. Because the present spillway capacity would not pass the SDF without overtopping the dam and failure of the dam would increase the downstream hazard to life and property, the spillway is rated as seriously inadequate and the dam is rated as unsafe, non-emergency.

(2) A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiencies
Embankment	Brush and trees up to 18-inch diameter on crest, slopes and toe of dam. Ice house foundation walls contain trash that may attract rodents.
Below toe, at left end of dam	A soft, wet seepage area. Estimated discharge 1/4 GPM.
Outlet Works	Poorly constructed downstream wall of the valve pit. Missing wheel on one of the two operating 8-inch outlet valves. Missing entrance cover plate. No evidence of intake control facilities. Outlet pipe under constant reservoir pressure.

(3) The facility is not properly maintained, as evidenced by the extensive growth of trees on the embankment and the condition of the outlet works valve pit.

(4) There is no warning system or evacuation plan in effect at the present time.

b. Adequacy of Information: There is no information available on the design, construction or past operation and maintenance of the dam. Data collected by survey, visual inspection and computations performed as part of this study are sufficient for Phase I dam safety assessment.

c. Urgency: The recommendations in paragraph 7.2 should be implemented immediately.

d. Necessity for Further Investigations: In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by a Professional Engineer, experienced in the design and construction of dams will be necessary.

7.2 Recommendations and Remedial Measures.

a. The following investigations and remedial measures are recommended for immediate implementation by the owner:

(1) Engage a Professional Engineer, experienced in the design and construction of dams, to perform additional hydrologic and hydraulic analysis to more accurately ascertain the present spillway capacity. As a result of the analysis, implement the necessary remedial measures to upgrade the present spillway capacity to the required Spillway Design Flood.

(2) Remove trees and brush from the crest and slopes of the embankment, under the supervision of a Professional Engineer. The trash inside the ice house foundation walls should be removed to avoid attracting rodents.

(3) Periodically measure the rate and clarity of the seepage at the toe of the dam and observe the condition of the unprotected upstream slope that is susceptible to erosion by wave action. Take appropriate action as necessary.

(4) Make necessary repairs to the downstream wall of the outlet works valve pit, furnish a wheel for the 8-inch upstream gate valve and provide a hatch and lock to secure the facility against unauthorized operation of the valves. If there are no intake control facilities for the outlet pipe, such facilities should be provided to eliminate the constant reservoir pressure on the pipe.

b. In addition, it is recommended that the owner take the following precautionary operational and maintenance measures:

(1) Develop a detailed emergency operation procedure and warning

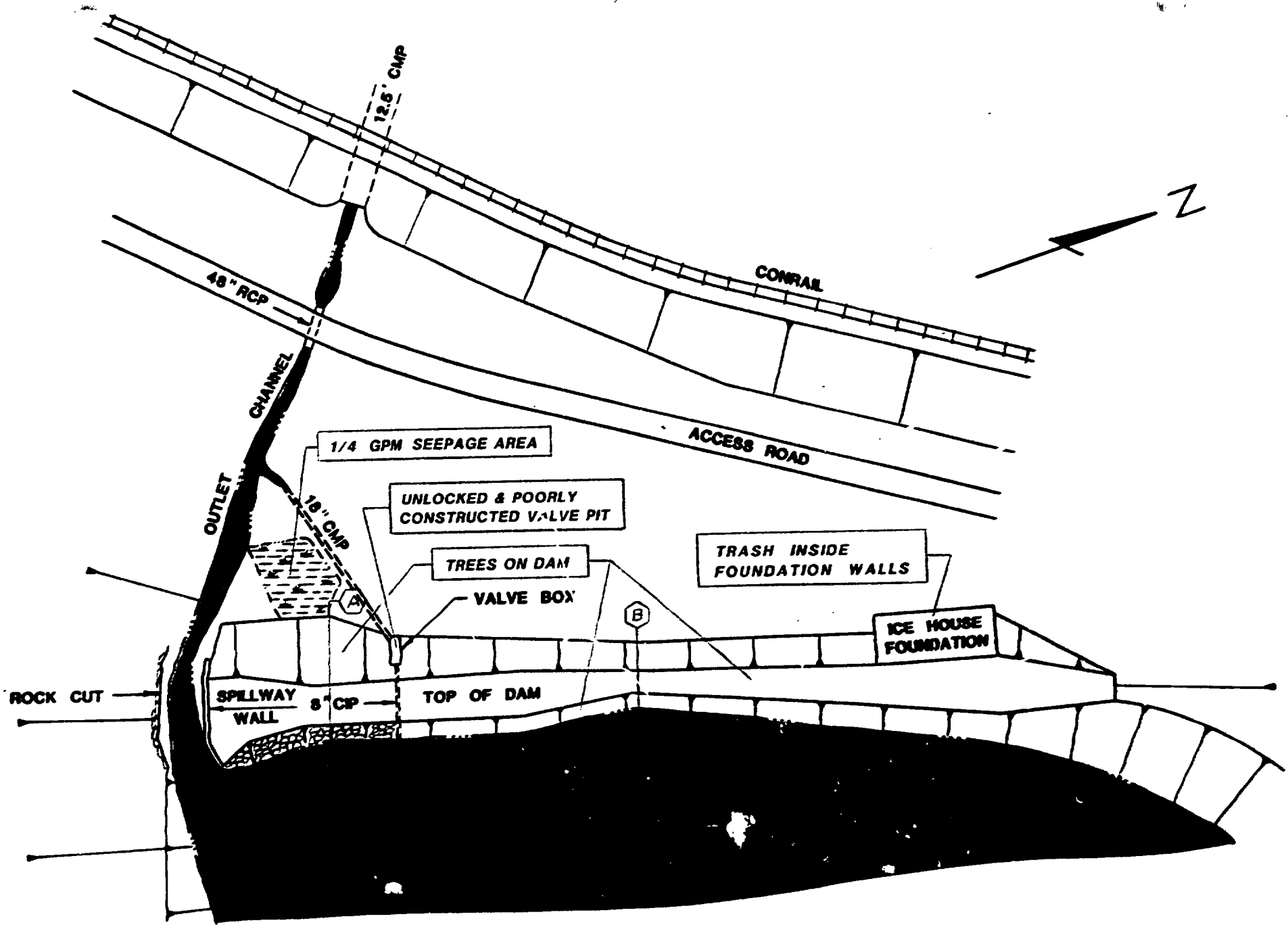
system to facilitate timely and orderly evacuation of the downstream population if any hazardous conditons at the dam are observed.

(2) When warnings of a storm of major porportions are given by the National Weather Service, activate the emergency operating and warning system procedures.

(3) After satisfactory implementation of the remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a Professional Engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

APPENDIX A

VISUAL INSPECTION - CHECKLIST AND FIELD SKETCHES



GLENWOOD LAKE DAM
GENERAL PLAN - FIELD INSPECTION NOTES

EXHIBIT A-1

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO. ____
CALCULATED BY ____ DATE 2-3-81
CHECKED BY ____ DATE ____
SCALE HORZ. 1" = 100' VERT. 1" = 4'

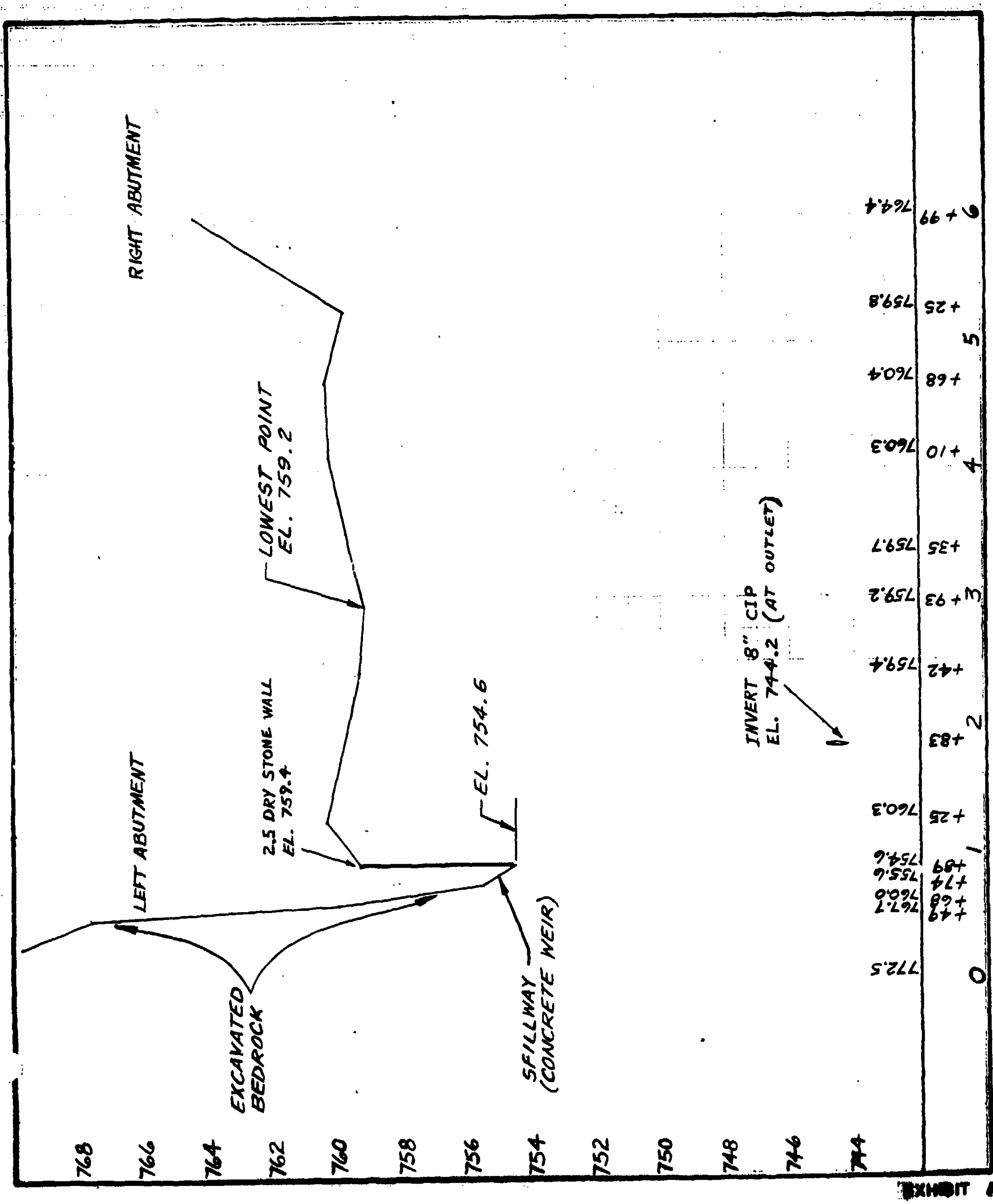
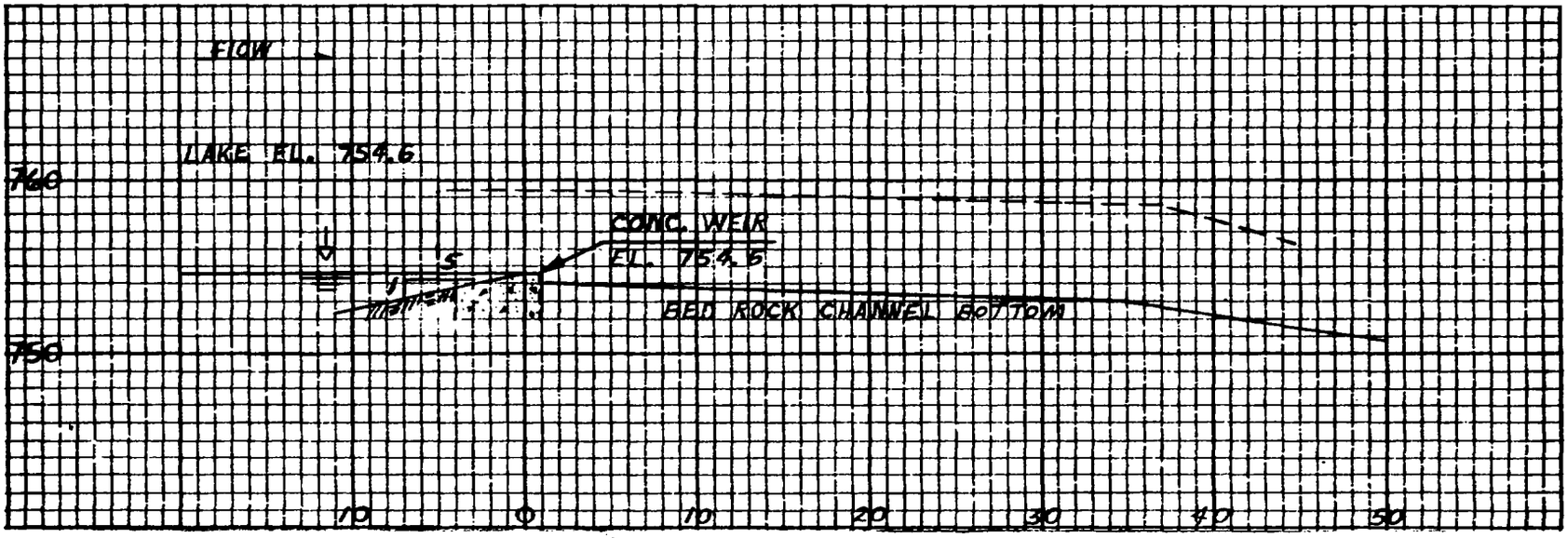
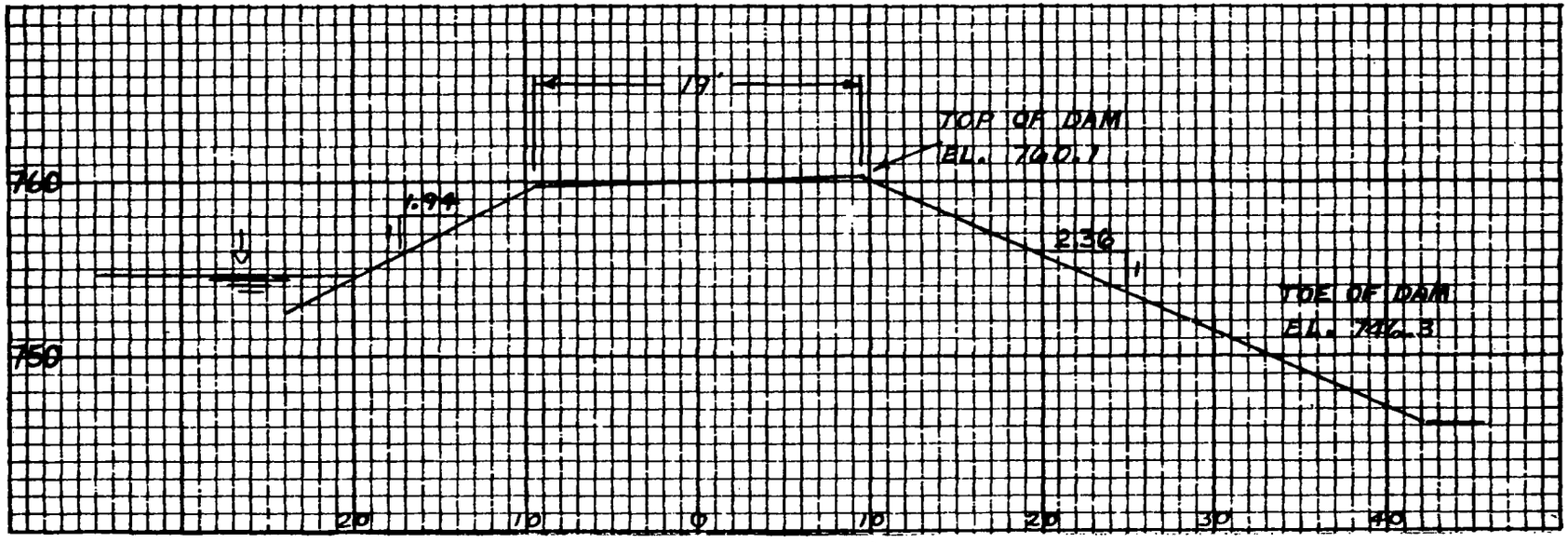


EXHIBIT A-2

TYPICAL DAM SECTIONS

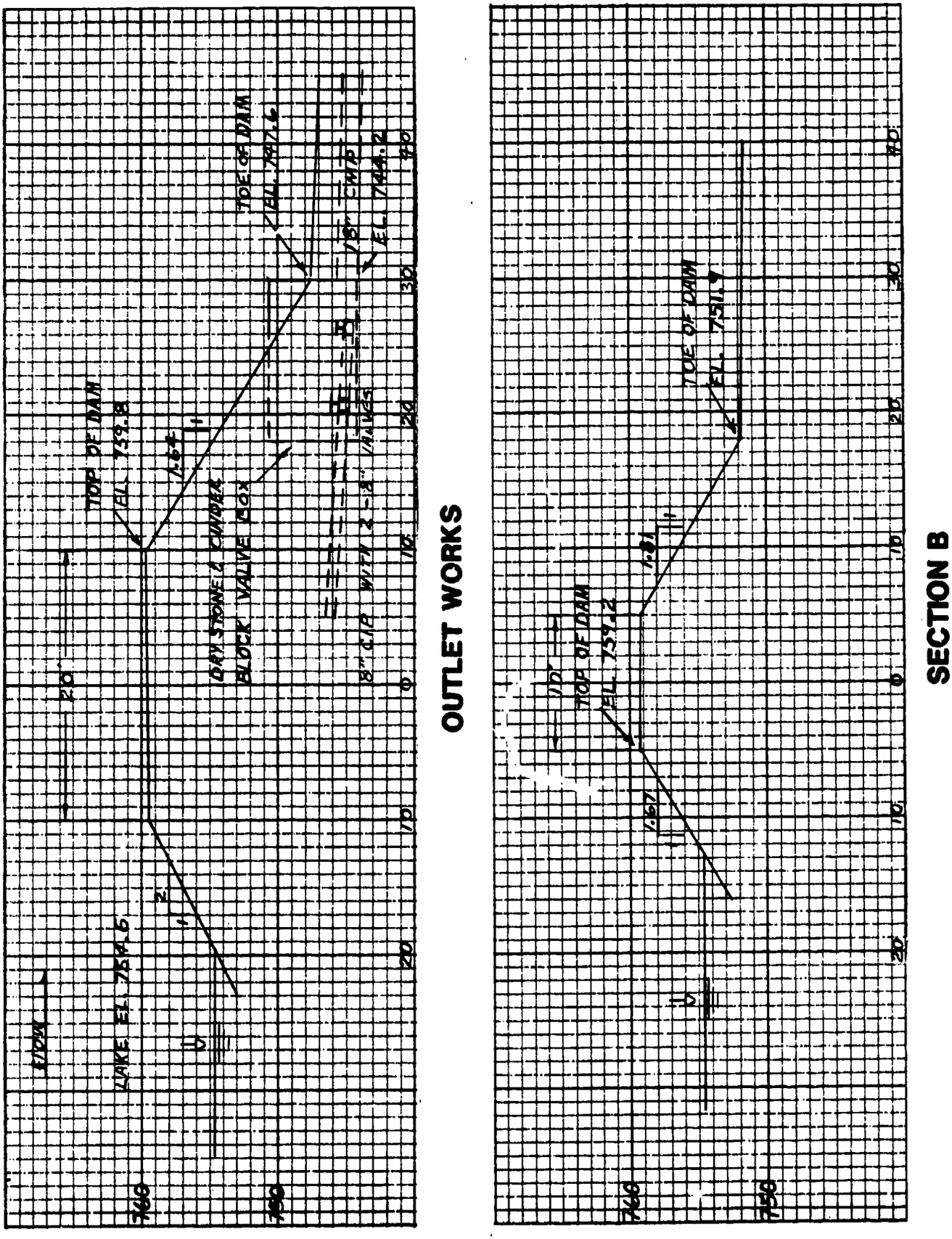


SPILLWAY SECTION



SECTION A

EXHIBIT A-8



TYPICAL DAM SECTIONS

EXHIBIT A-4

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Glenwood Lake Dam STATE Pennsylvania COUNTY Lackawanna

Local Name - DeFazio Ice Pond NDI # PA — 00327 PENNDER # 35-143

TYPE OF DAM Earth Fill SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 12-9-1980 WEATHER Cloudy TEMPERATURE 41° @ 11:00 a.m.

POOL ELEVATION AT TIME OF INSPECTION 754.6 M.S.L.

TAILWATER AT TIME OF INSPECTION 742.0 M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
V. Butler, GTS		John Chernesky, DER
J. Diaz, GTS		
R. Mather, GTS		

RECORDED BY V. Butler

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00327
SURFACE CRACKS	None
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Good
RIPRAP FAILURES	Intermittent sandstone riprap is limited to an area between the spillway and the outlet works on upstream face.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00327
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	A 35' diameter soft wet area with marsh type weeds below the downstream toe, between valve pit and spillway. No seepage thru embankment.
ANY NOTICEABLE SEEPAGE	About 1/4 GPM from the above seepage area. Back wall in the valve pit was wet.
STAFF GAGE AND RECORDER	None
DRAINS	None
ROCK OUTCROPS	Sandstone and conglomerate bedrock is exposed on the bottom of spillway channel, its left wall and the left abutment (Strike N 10°E, Dip 5°SW).
DAM FOUNDATION TREES, OTHER	The entire dam is covered with brush and trees to 18" diameter. The foundation walls of an ice house built into the right downstream slope of the dam contain an accumulation of trash.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00327
INTAKE STRUCTURE	Not visible.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	8" C.I. Pipe
OUTLET STRUCTURE	A stone masonry valve box in good condition, except for its loose cinder block entrance walls and its missing cover plate.
OUTLET CHANNEL	Buried 18" C.M.P. from valve pit to creek. Total leakage from pit into the outlet CMP was about 1/4 GPM.
GATE(S) AND OPERATIONAL EQUIPMENT	Two 8" gate valves. Upstream valve was open and had no wheel. The downstream valve was closed, had a wheel and operated easily.
CONCRETE SURFACES CRACKS, SPALLING JOINTS	Spillway wall right side dry masonry with rough concrete cap. (sound condition). Valve pit masonry walls (good). Rough concrete weir in good condition (1 on 5 back slope).

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00327
TYPE AND CONDITION	No emergency spillway.
APPROACH CHANNEL	N.A.
SPILLWAY CHANNEL AND SIDEWALLS	N.A.
STILLING BASIN PLUNGE POOL	N.A.
DISCHARGE CHANNEL	N.A.
BRIDGE AND PIERS EMERGENCY GATES	N.A.

SERVICE SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00327
TYPE AND CONDITION	Concrete broad crested weir in good condition (20.0' long and 4.8' wide with 1 on 5 back slope toward the lake). The right wall was dry stone masonry with a concrete cap, both in good condition. The left wall and outlet channel are excavated in sound sandstone bedrock.
APPROACH CHANNEL	A dry stone wall flared to about 24' wide in an upstream distance of 13'.
OUTLET STRUCTURE	None
DISCHARGE CHANNEL	The channel is in excavated sound bedrock for about 50' below the weir. In the next 40' large sandstone boulders in the channel act as energy dissipators. Below this, the channel discharges into a natural wooded channel.

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00327
MONUMENTATION SURVEYS	No instrumentation.
OBSERVATION WELLS	N.A.
WEIRS	N.A.
PIEZOMETERS	N.A.
OTHERS	N.A.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00327
SLOPES: RESERVOIR	Gentle slopes rising from pond. No evidence of conditions that could affect the stability of the dam.
SEDIMENTATION	Slight siltation at inlet.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	A 4.0' diameter RCP about 250' downstream serves as a culvert for an access road. A 12.5' diameter CMP about 300' below dam serves as a culvert for a railroad fill that is 5' to 7' higher than the dam crest. Downstream at 900'± is a 6.0' X 24.0' box culvert and at 1000'± a 3.8 X 10.7 box culvert.
SLOPES: CHANNEL VALLEY	Downstream of the dam the stream channel is entrenched in the flood plan 3.5 to 8 5' deep and 9' to 12' bottom width.
APPROXIMATE NUMBER OF HOMES AND POPULATION	A cigar plant (Continental Cigar Co.) 1200' downstream with about 70 employees is located about 200' left of the stream.
WATERSHED DESCRIPTION	Wooded mountain areas with limited coal strip areas.

APPENDIX B

ENGINEERING DATA - CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Glenwood Lake Dam

ITEM	REMARKS NDI# PA - 00327
PERSONS INTERVIEWED AND TITLE	Roland White, Bureau of Public Works Pennsylvania Department of General Services (DGS)
REGIONAL VICINITY MAP	See Exhibit E-1, Appendix E.
CONSTRUCTION HISTORY	Local resident (Robert Kane) reports the dam was constructed about 50 years ago by the DeFazio Family of Moosic, Pennsylvania, for harvesting of ice. The dam and adjoining land was purchased in the late 1970's by DGS for a proposed County prison site.
AVAILABLE DRAWINGS	There are no drawings available in DER files or DGS files. A general plan is presented in Exhibit A-1, Appendix A.
TYPICAL DAM SECTIONS	See Exhibits A-1 thru A-4, Appendix A.
OUTLETS PLAN DETAILS DISCHARGE RATINGS	 Not Available. Not available. A typical section is shown in A-4, Appendix A. Not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00327
SPILLWAY PLAN SECTION DETAILS	None available. A general plan is shown in Exhibit A-1, Appendix A. A typical section is shown in Exhibit A-3, Appendix A.	
OPERATING EQUIP- MENT PLANS AND DETAILS	None available.	
DESIGN REPORTS	None available.	
GEOLOGY REPORTS	None available.	
DESIGN COMPUTATIONS HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available.	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00327
BORROW SOURCES	No information available.	
POST CONSTRUCTION DAM SURVEYS	None available other than survey made on 12-9-80 for the present inspection report.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available.	
HIGH POOL RECORDS	None available.	
MONITORING SYSTEMS	None	
MODIFICATIONS	No information available.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00327
PRIOR ACCIDENTS OR FAILURES	None reported.
MAINTENANCE RECORDS MANUAL	None available.
OPERATION RECORDS MANUAL	None available.
OPERATIONAL PROCEDURES	Self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None available.
MISCELLANEOUS	

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00327
PENNDER ID # 35-143

SIZE OF DRAINAGE AREA: 2.57 square miles

ELEVATION TOP NORMAL POOL: 754.6 STORAGE CAPACITY 20 acre-feet

ELEVATION TOP FLOOD CONTROL POOL N.A. STORAGE CAPACITY N.A.

ELEVATION MAXIMUM DESIGN POOL Unknown STORAGE CAPACITY Unknown

ELEVATION TOP DAM: 759.2 STORAGE CAPACITY: 76 acre-feet

SPILLWAY DATA

CREST ELEVATION: 759.2 feet

TYPE: Broad crested concrete weir

CREST LENGTH: 20.0 feet

CHANNEL LENGTH: Approximately 50 feet

SPILLOVER LOCATION: left abutment

NUMBER AND TYPE OF GATES: None

OUTLET WORKS

TYPE: 8" Cast Iron Pipe

LOCATION: Approximately 90 feet right of spillway wall

ENTRANCE INVERTS: Unknown

EXIT INVERTS: 744.2 feet

EMERGENCY DRAWDOWN FACILITIES: 8" gate valve at outlet end

HYDROMETEOROLOGICAL GAGES

TYPE: None

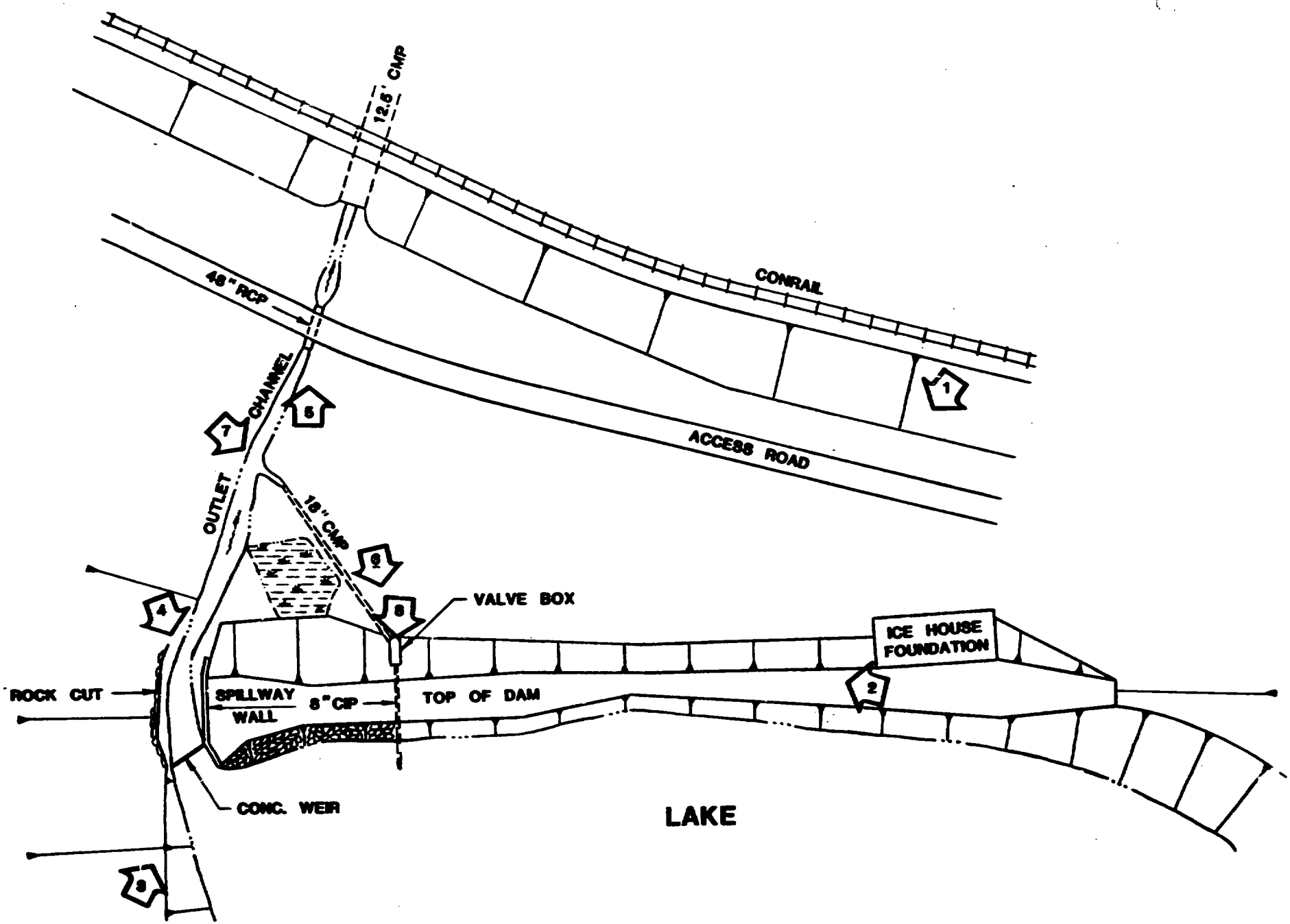
LOCATION: None

RECORDS: None

MAXIMUM NON-DAMAGING DISCHARGE: 450 cfs

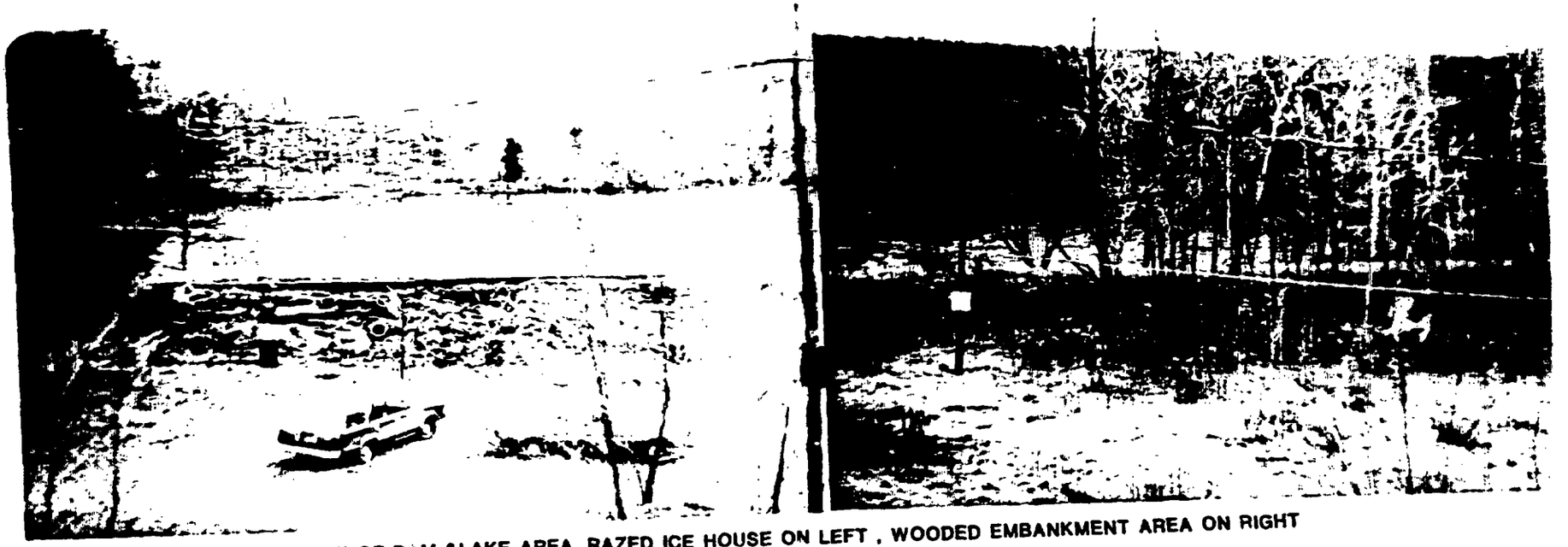
APPENDIX C

PHOTOGRAPHS

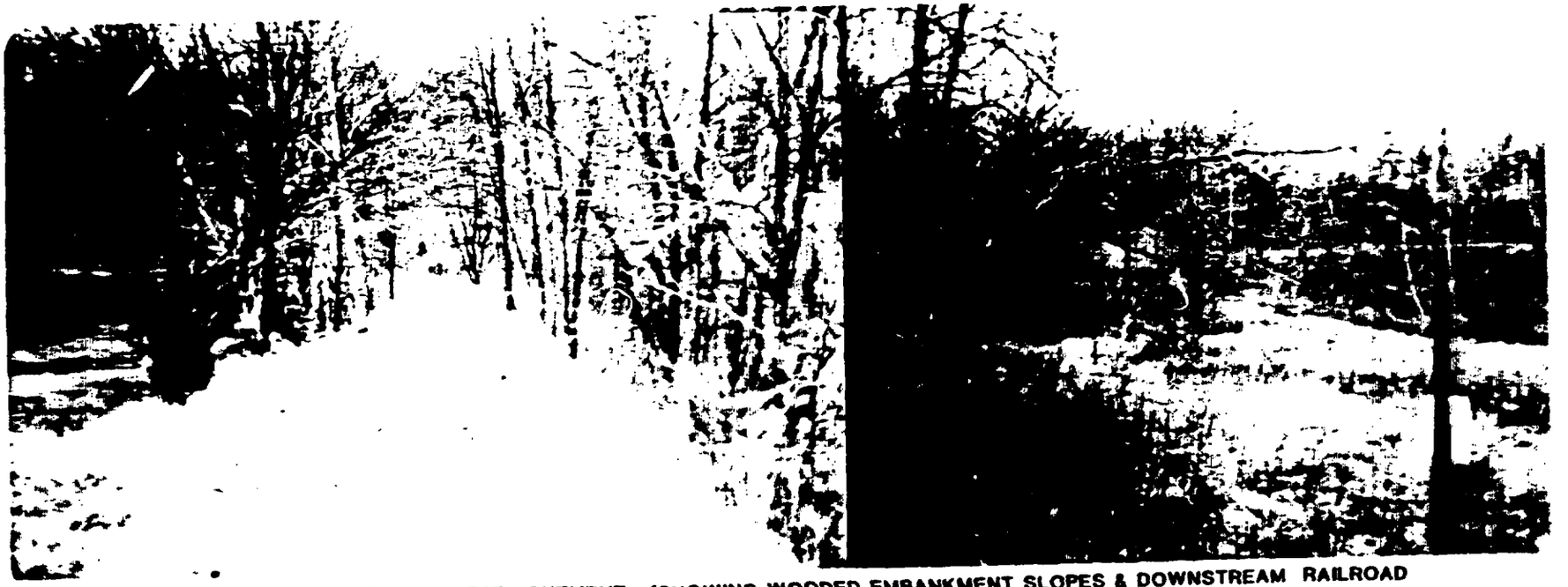


GLENWOOD LAKE DAM
PHOTOGRAPHS LOCATION MAP

EXHIBIT 9-1



1. UPSTREAM VIEW OF DAM &LAKE AREA. RAZED ICE HOUSE ON LEFT , WOODED EMBANKMENT AREA ON RIGHT



2. CENTER LINE OF DAM FACING LEFT ABUTMENT. (SHOWING WOODED EMBANKMENT SLOPES & DOWNSTREAM RAILROAD EMBANKMENT, ON RIGHT)

3. SPILLWAY WALL & ROCK CUT. VIEW FACING DOWNSTREAM

4. SPILLWAY WALL, WEIR AND ROCKCUT VIEW FACING UPSTREAM

5. ACCESS ROAD CULVERT (4' DIA.) & RAILROAD FILL (BACKGROUND) DOWNSTREAM OF DAM

6. VALVE PIT AT DOWNSTREAM TOE OF DAM

7. OUTLET OF 18" CMP DRAIN FROM VALVE PIT

8. INSIDE VIEW OF VALVE PIT SHOWING 8" GATE VALVE

APPENDIX D

HYDROLOGY AND HYDRAULICS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY INVESTIGATIONS

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

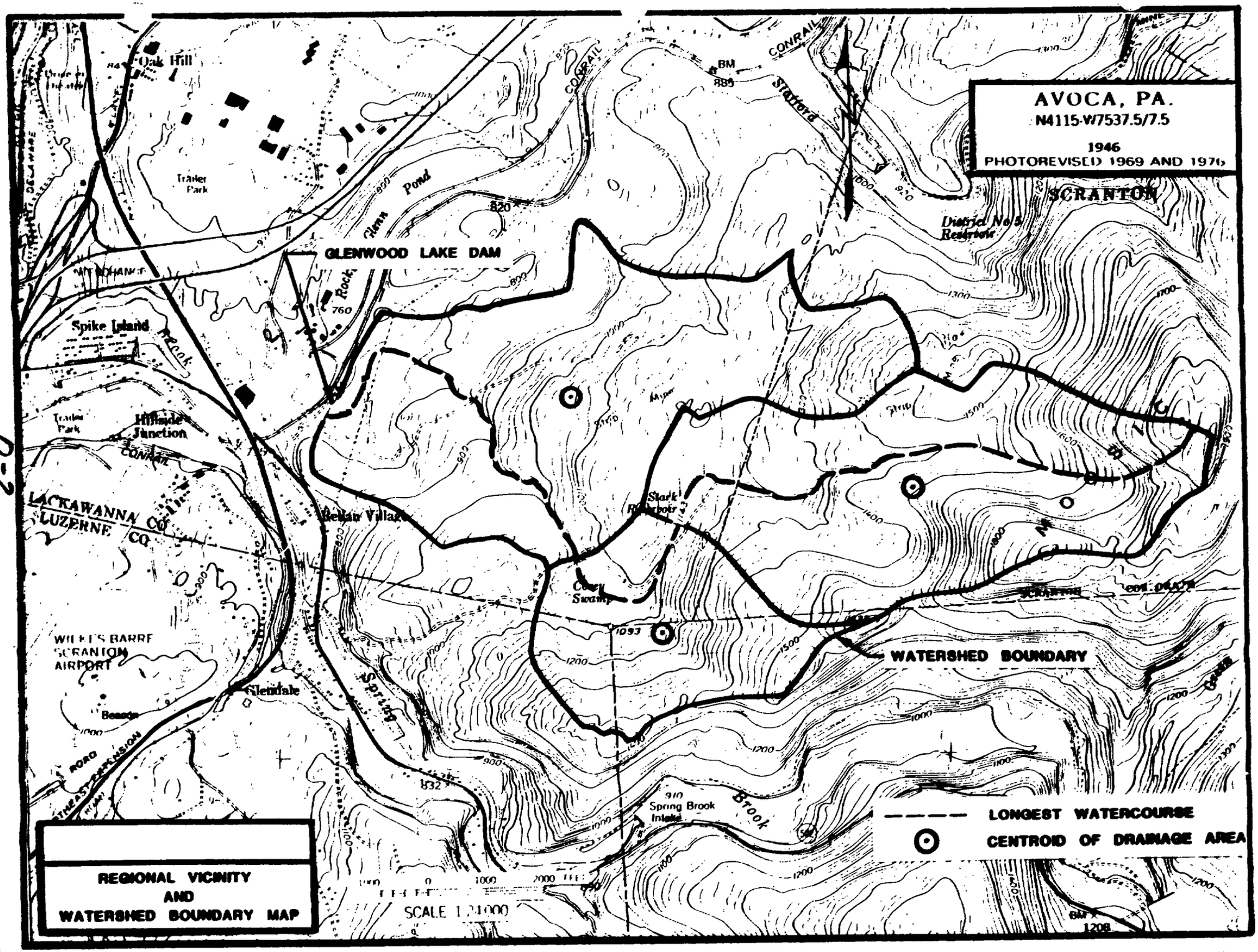
The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the over-topping potential of the dam, and (2) estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam over-topping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would over-top the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program, refer to the Users Manual for the Flood Hydrograph Package (HEC-1), Dam Safety Investigations prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.


AVOCA, PA.
N4115-W7537.5/7.5
1946
PHOTOREVISED 1969 AND 1976
GLENWOOD LAKE DAM
SCRANTON
Oak Hill
Trailer Park
Glenn Pond
CONRAIL
Stafford
District No. 5 Registrar
Spike Island
Creek
Hillside Junction
LACKAWANNA CO.
LUZERNE CO.
Stark Reservoir
Clark Swamp
WILKES BARRE SCRANTON AIRPORT
Glendale
Spring Brook
Spring Brook Intake
WATERSHED BOUNDARY
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
REGIONAL VICINITY AND WATERSHED BOUNDARY MAP
SCALE 1:24000
0
1000
2000 FEET

D-2

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO. 1 OF
CALCULATED BY [signature] DATE 6/81
CHECKED BY DATE
SCALE

GENERAL DATA - GLENNWOOD LAKE

RIVER BASIN	SUSQUEHANNA
STREAM NAME	COVEY CREEK trib. to Spring Brook
NDI I.D. NO	PA-0327
DER I.D. NO	35-143
OWNER	Pa. DER
LOCATION	MOOSIC BORO
CO.	LACKAWANNA
QUAD.	AVOCA
LAT.	41° 20' - 59"
LONG.	75° 42' - 15"
SIZE	SMALL
HAZARD	HIGH
DRAINAGE AREA	2.57 mi^2

Watershed Features

WOODED · STEEP SLOPES
SOME STRIP MINING
NO DOWNSTREAM DAMS
2 UPSTREAM DAMS
COVEY SWAMP DAM DER 35-043
STARK RESERVOIR DER 35-041
OWNER - Pa. Gas & Water (both)

GLENNWOOD LAKE DAM ALSO KNOWN AS MAGARINE DAM & D. FABIO'S ICE POND

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB NDI PA
SHEET NO ____ OF ____
CALCULATED BY SJM DATE 6/81
CHECKED BY ____ DATE ____
NAME GLENWOOD DAM

RAINFALL & HYDROGRAPH DATA

BASIN - SUSQUEHANNA

REF. - HYDROMETEOROLOGICAL REPORT NO. 40

ZONE - II

24 PMP (200 mi²) = 22.2"

GEOGRAPHIC ADJ. FACTOR = 0.97

PMP = 21.5"

% INDEX RAINFALL - DR. AREA < 10 mi²

DURATION	PERCENT
6 hr	118
12	127
24	136
48	142

$C_p = 0.62$
$C_T = 1.50$
$T_p = C_T (LL_{ca})^{0.3}$ } ZONE II

SUBAREA NAME	DR. AREA	L_{ca}	L	T_p
STARK RESERVOIR	0.99	1.16	2.25	2.00
COVEY SWAMP	0.45	0.45	1.23	1.25
GLENWOOD LAKE	1.13	1.14	2.02	1.93
	2.57			

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB _____

SHEET NO _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

ANALYSIS PROCEDURE

1) COMPUTE RUNOFF STARK RESERVOIR
2.) ROUTE THRU STARK RESERVOIR
3.) ROUTE OUTFLOW TO COVEY SWAMP
4.) COMPUTE SUB-AREA RUNOFF TO COVEY SWAMP
5) COMBINE HYDROGRAPHS
6.) ROUTE THRU COVEY SWAMP
7.) ROUTE OUTFLOW TO GLENWOOD
8.) COMPUTE SUB-AREA RUNOFF TO GLENWOOD
9.) COMBINE HYDROGRAPHS
10.) ROUTE THRU GLENWOOD
11.) AS THE CRITICAL DOWNSTREAM SECTIONS ARE CULVERT / BRIDGE SECTIONS DEVELOPE RATING CURVES INDEPENDANT OF HEC 1DB DIST. TO DOWNSTREAM SECTION ARE SHORT THEREFORE CHANNEL ROUTING IS NEGLIGIBLE

NOTE 11.) VALID ONLY IF T.W. FROM R.R EMBANKMENT DOES NOT SUBMERGE SPILLWAY - PRELIMINARY CHECK INDICATES FLOW > 2000 cfs REQ'D TO AFFECT SPILLWAY

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists,

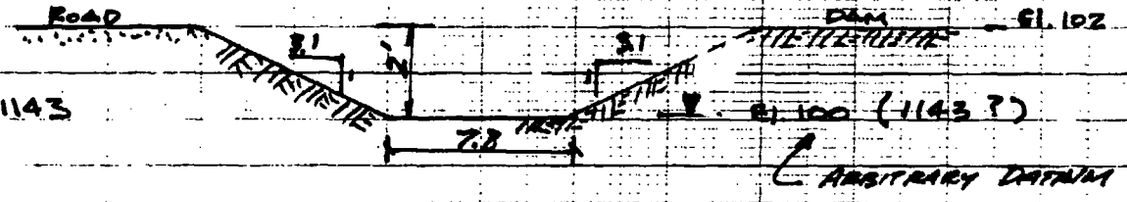
JOB NDI - PA GLENWOOD
SHEET NO ____ OF ____
CALCULATED BY ____ DATE 6/21
CHECKED BY ____ DATE ____
SCALE ____

STARK RESERVOIR DATA

DAM HT. = 20'
CREST LENGTH = 200'
TYPE - EARTH FILL
SLOPES - 2:1 Up & Dwn stm } 1916 INSP. REPORT
STORAGE - 10 MG
SURFACE - 25 Ac. } 1943 RPT.

Above dimensions approx. correct as per field inspection.

SPILLWAY SECTION

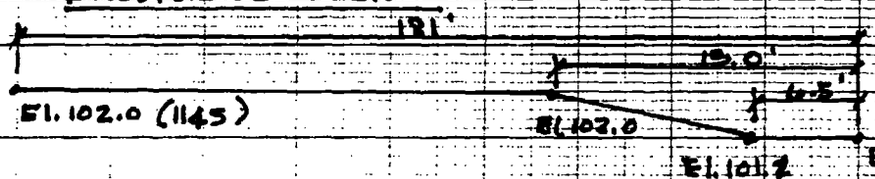


{El. 100 = El. 1143

DAM SECTION

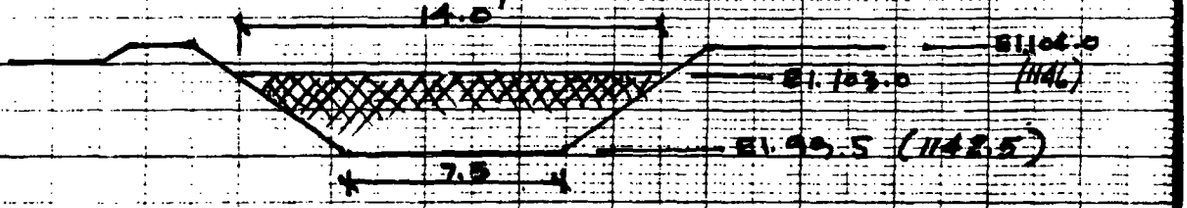
DAM HAS LOW SPOT ON RT. ABUT.

TRANSFORMED SECTION



PREVIOUS BREACH

THE POND HAS BEEN PREVIOUSLY BREACHED BY A CHANNEL IN THE TOPOGRAPHIC SADDLE TO THE NORTHWEST. THIS CHANNEL IS PRESENTLY BLOCKED BY A BEAVER DAM WHICH HAS A SMALL AMOUNT OF SEEPAGE THRU IT



THE BEAVER DAM IS 1.0 ABOVE THE EARTH DAM - UNLESS STAGES REACH 104± IT WILL BE ASSUMED THAT ALL FLOW DISCHARGES IN THE DIRECTION OF COVEY SWAMP

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

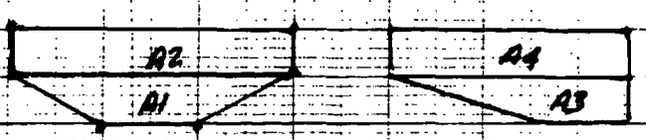
JOB NDI - MA GLENWOOD
SHEET NO ____ OF ____
CALCULATED BY JPM DATE 6/24
CHECKED BY ____ DATE ____
SCALE ____

(STACK RESERVOIR CONTINUED.)

RESERVOIR STORAGE

ELEV.	AREA	
~~82~~ 1125	0	(BOT OF DAM)
~~100~~ 1143	9.4	(USGS Pool)
~~104~~ 1147	25	(EST - CONTOUR)

STAGE/DISCHARGE - HEC1DB - NO LOW LEVEL OUTLET
ASSUME CRITICAL DEPTH THROUGH SPILLWAY SECTION
& LOW PT W/ REMAINDER OF DAM LEVEL.
USE $\frac{Q^2}{g} = \frac{A^3}{T}$




```
10 FOR Y=.5TO 6STEP .5
20 Y1=Y:IF Y[2THEN 30:Y1=2
30 Y2=Y-2:IF Y2]0THEN 40:Y2=0
40 Y3=Y-1.1:IF Y3]0THEN 50:Y3=0:GOTO 60
50 IF Y[2THEN 60:Y3=.9
60 Y4=Y2
70 A1=(7.8+3.1*Y1)*Y1:A2=14*Y2:A3=(6.5+4.72*Y3)*Y3
80 A4=15*Y4:A=A1+A2+A3+A4
90 T=7.8+6.2*Y1:IF Y[1.1THEN 100:T=T+6.5+9.44*Y3
100 Q=SQR(32.2*A*A*A/T)
110 E=Y+1143
120 PRINTUSING 500,E,Q
130 NEXT Y
500% ####.#  #####
501% ELEV.   DISCH.
502%------   -----
```

ELEV.	DISCH.
1143.5	17
1144.0	54
1144.5	112
1145.0	221
1145.5	360
1146.0	520
1146.5	699
1147.0	895
1147.5	1106
1148.0	1331
1148.5	1570
1149.0	1622

→ RATING CURVE

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO. _____ OF _____
CALCULATED BY _____ DATE 6/81
CHECKED BY _____ DATE _____
SCALE _____

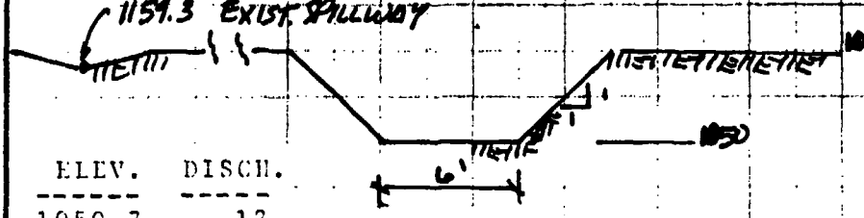
COVEY SWAMP DAM DATA

EARTHFILL DAM
Ht = 20'
MAX STORAGE - UNREGULATED = 10 MG
MAX. POOL AREA 25 Ac.
LENGTH CREST = 450'

ASSUMED STORAGE FOR HEC IDB

ELEV.	SURFACE
1040	0
1050	5.8
1059.3	25 Acres

ASSUMED NORMAL POOL ELEV. 1150
DAM IS BREACHED TO THIS ELEVATION HOWEVER BREACH IS SMALL & STORAGE AT PEAK FLOW COULD BE SIGNIFICANT - INCLUDE AS DAM IN HEC-IDB USING THE BREACH AS A SPILLWAY.



ASSUME CRITICAL DEPTH CONTROL ON BREACH SECTION

ELEV.	DISCH.
1050.7	12
1051.4	38
1052.1	75
1052.8	123
1053.4	182
1054.1	252
1054.8	335
1055.4	430
1056.1	528
1056.8	659
1057.4	794
1058.1	944
1058.7	1107
1059.4	1286
1060.0	1481
1060.7	1691
1061.3	1918
1062.0	2161
1062.6	2421
1063.3	2698
1063.7	2803
1064.4	3235
1065.2	3580
1065.9	3950

← RATING CURVE

PROGRAM 7

```
600 FOR E=1150.5 TO 1162.0 STEP .5
610 Y=E-1150:IF E[=1160THEN 620:Y=10
620 A=(6+1.25*Y)*Y:IF E[=1160THEN 630:A=A+31*(E-1160)
625 T=31:GOTO 640
630 T=6+2.2*Y
640 Q=SQR(32.2*A*A*A/T):V=Q/A:E0=E+V*V/64.4
650 PRINTUSING 500,E0,Q
660 NEXT E
```

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

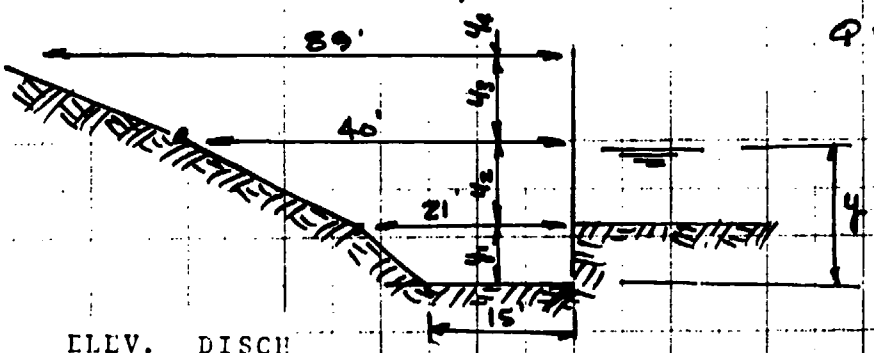
SHEET NO _____ OF _____
CALCULATED BY SJM DATE 6/81
CHECKED BY _____ DATE _____
SCALE _____

GLENNWOOD DAM DATA

SPILLWAY

SHAPE - IRREG. TRAPEZOID
OUTLET CHANNEL SLOPES 8.8% ∴ ASSUME CRITICAL DEPTH CONTROL FOR SPILLWAY RATING

$$Q = \sqrt{\frac{A^3 g}{T}}$$



PROGRAM

```
800 FOR E=756 TO 772
810 Y=E-755.1:Y1=Y:Y2=0:Y3=0:Y4=0
820 IF E[760THEN 860
830 Y1=4.9:Y2=E-760:IF E[767.7THEN 860
840 Y2=7.7:Y3=E-767.7:IF E[772.5THEN 860
850 Y3=4.8:Y4=E-772.5
860 A1=(15+.68*Y1)*Y1:A2=(21+1.23*Y2)*Y2
870 A3=(40+5.1*Y3)*Y3:A4=89*A4
880 A=A1+A2+A3+A4:T=15+1.36*Y1+2.46*Y2+10.2*Y3+20.1*Y4
890 Q=SQR(32.2*A*A*A/T):V=Q/A:E0=E+V*V/64.4
900 PRINTUSING 500,E0,Q
910 NEXT E
```

ELEV.	DISCH
756.4	74
757.8	233
759.2	450
760.6	719
762.0	1037
763.3	1370
764.5	1759
765.8	2209
767.0	2721
768.3	3298
769.5	3944
770.8	4660
771.8	5310
772.5	5842
773.4	6619
774.4	7628
775.4	8865

RATING CURVE

TRANSFORMED TOP OF DAM

LENGTH	ELEV.
0	759.2
65	759.4
162	759.8
438	760.4

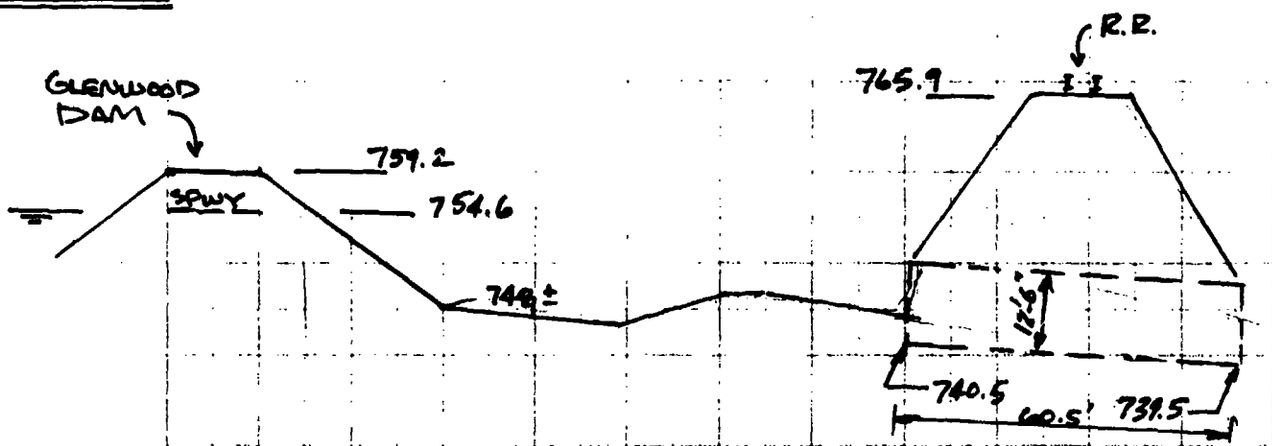
STORAGE DATA

ELEV.	SURFACE AREA
748.0	0 (ASSUMED LAKE BOTTOM)
754.6	9.2
760.0	16.5
770.0	40.4 Ac.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SHEET NO _____ OF _____
CALCULATED BY _____ DATE 6/81
CHECKED BY _____ DATE _____
SCALE _____

CONDITIONS DOWNSTREAM OF GLENWOOD DAM
R.R. EMB.



SECTION THRU DAM & RR.
NTS

RATE R.R. CULVERT USING INLET CONTROL & B.P.R. CHARTS
CULVERT 12'-6" ϕ CMP.

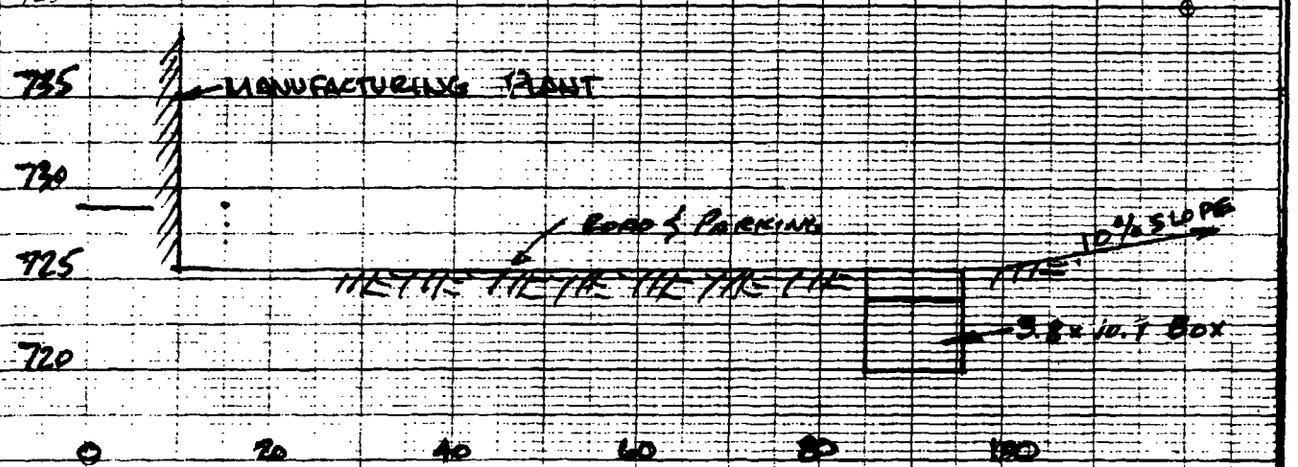
HW/D	Q	ELEV.
1	1400	753.0
1.25	1900	756.1
1.50	2200	759.3
2.0	2800	765.5

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB NDI - PA
SHEET NO ____ OF ____
CALCULATED BY ____ DATE 6/81
CHECKED BY ____ DATE ____
SCALE ____

(DOWNSTREAM CONDITIONS CONTINUED)

DAMAGE CENTER SECTION



RATE SECTION USING CRITICAL FLOW OVER ROAD & PRESSURE FLOW IN BOX
START W.S. AT ROAD LEVEL & USE DOWNSTREAM BANKFULL CONDITIONS AS TAILWATER FOR CULVERT FLOW
y_1 = Elev. - 725.3 = HEAD ON BOX CULVERT
y_2 = Elev. - 725.3 = CRIT. FLOW DEPTH.

```
1000 FOR E=726 TO 732
1010 Y1=E-723.8:A1=40.7:Q1=.6*A1*SQR(64.4*H1)
1020 Y2=E-725.3:IF Y2]0THEN 1030:Y2=0
1030 A2=95.7*Y2+5*Y2*Y2:T=95.7+10*Y
1040 Q2=SQR(32.2*A2*A2*A2/T)
1050 Q=Q1+Q2:A=A1+A2:V=Q/A
1060 E0=E+V*V/64.4
1070 PRINTUSING 500,E0,Q
1080 NEXT E
```

ELEV.	DISCH.
726.1	335
727.6	1367
729.1	2936
730.8	5038
732.5	7691
734.3	10926
736.1	14773

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1          A1       NATIONAL DAM INSPECTION PROGRAM
    2          A2       OVERTOPPING ANALYSIS
    3          A3       GLENWOOD LAKE  PA0327
    4          B   100       0      15       0       0       0       0       0      -4       0
    5          B1    5       0       0       0       0       0       0       0       0       0
    6          J     1       6       1       0       0       0       0       0       0       0
    7          J1   .1      .2      .3      .4      .5       1       0       0       0       0
    8          K     0       1       0       0       0       0       1       0       0       0
    9          K1       INFLOW TO STARK RES.
   10          M     1       1     .99       0    2.57       0       0       0       1       0
   11          P     0    21.5     118     127     136     142       0       0       0       0
   12          T     0       0       0       0       0       0       1     .05       0       0
   13          W     2     .62       0       0       0       0       0       0       0       0
   14          X  -1.5    -.05       2       0       0       0       0       0       0       0
   15          K     1       2       0       0       0       0       1       0       0       0
   16          K1       ROUTE THRU STARK RES.
   17          Y     0       0       0       1       1       0       0       0       0       0
   18          Y1    1       0       0       0       0       0   -1143      -1       0       0
   19          Y4 1143    1144    1145    1146    1147    1148    1149       0       0       0
   20          Y5    0      54     221     520     895    1331    1822       0       0       0
   21          SA    0     9.4      25       0       0       0       0       0       0       0
   22          SE 1125    1143  1147.0       0       0       0       0       0       0       0
   23          SS 1143       0       0       0       0       0       0       0       0       0
   24          SD 1145       3     1.5     200       0       0       0       0       0       0
   25          K     1       3       0       0       0       0       1       0       0       0
   26          K1       ROUTE TO COVEY SWAMP
   27          Y     0       0       0       1       1       0       0       0       0       0
   28          Y1    1       0       0       0       0       0       0       0       0       0
   29          Y6  .09    .045     .09    1102    1160    2200   .0667       0       0       0
   30          Y7    0    1160     200    1120     305    1115     335    1102     345    1102
   31          Y7  375    1115     450    1120    1200    1160       0       0       0       0
   32          K     0       4       0       0       0       0       1       0       0       0
   33          K1       SUBAREA RUOFF TO COVEY SWAMP
   34          M     1       1     .45       0    2.57       0       0       0       1       0
   35          P     0    21.5     118     127     136     142       0       0       0       0
   36          T     0       0       0       0       0       0       1     .05       0       0
   37          W  1.25     .62       0       0       0       0       0       0       0       0
   38          X  -1.5    -.05       2       0       0       0       0       0       0       0
   39          K     2       5       0       0       0       0       1       0       0       0
   40          K1       COMBINE HYDROGRAPHS
   41          K     1       6       0       0       0       0       1       0       0       0
   42          K1       ROUTE THRU COVEY SWAMP
   43          Y     0       0       0       1       1       0       0       0       0       0
   44          Y1    1       0       0       0       0       0   -1050      -1       0       0
   45          YA 1050  1052.1  1053.4  1054.8  1056.1  1057.4  1058.1  1059.4  1060.7    1062
   46          Y5    0      75     182     335     528     794     944    1286    1691    2161
   47          SA    0     5.8      25       0       0       0       0       0       0       0
   48          SE 1040    1050  1059.3       0       0       0       0       0       0       0
   49          SS 1050       0       0       0       0       0       0       0       0       0
   50          SD1059.3      3     1.5     429       0       0       0       0       0       0
```

D-12

```
K       1       7       0       0       0       0       1       0       0       0
K1    ROUTE FLOW TO GLENWOOD
Y       0       0       0       1       1       0       0       0       0       0
Y1      1       0       0       0       0       0       0       0       0       0
Y6   .08      .04     .08     905     940    4300    .071       0       0       0
Y7      0     940     190     920     220     910     225     905     240     905
Y7    250     915     300     920     600     940       0       0       0       0
K       0       8       0       0       0       0       1       0       0       0
K1    SUBAREA RUNOFF TO GLENWOOD
P       1       1    1.13       0    2.57       0       0       0       1       0
P       0    21.5     118     127     136     142       0       0       0       0
T       0       0       0       0       0       0       1    .05       0       0
W    1.93     .62       0       0       0       0       0       0       0       0
X    -1.5    -.05       2       0       0       0       0       0       0       0
K       2       9       0       0       0       0       1       0       0       0
K1    COMBINE HYDROGRAPHS
K       1      10       0       0       0       0       1       0       0       0
K1    ROUTE THRU GLENWOOD
Y       0       0       0       0       1       1       0       0       0       0
Y1      1       0       0       0       0       0    -754.6      -1       0       0
Y4  754.6   756.4   757.8   759.2   760.6     762   763.3   764.5   765.8     767
Y5      0      74     233     450     719    1037    1370    1759    2269    2721
SA      0     9.6    16.5    40.4       0       0       0       0       0       0
SE    748   754.6     760     780       0       0       0       0       0       0
SS  754.6       0       0       0       0       0       0       0       0       0
SD  759.2       0       0       0       0       0       0       0       0       0
SL      0      65     162     438       0       0       0       0       0       0
SV  759.2   759.4   759.8   760.4       0       0       0       0       0       0
K      99       0       0       0       0       0       0       0       0       0
```

D-13

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE= 81/06/11.
TIME= 13.12.06.

NATIONAL DAM INSPECTION PROGRAM
OVERTOPPING ANALYSIS
GLENWOOD LAKE PA0327

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1
RTIOS= .10 .20 .30 .40 .50 1.00

****

SUB-AREA RUNOFF COMPUTATION

INFLOW TO STARK RES.

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.99	0.00	2.57	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	118.00	127.00	136.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.00 CP= .62 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 45 END-OF-PERIOD ORDINATES, LAG= 1.99 HOURS, CP= .62 VOL= 1.00

9.	32.	63.	99.	137.	170.	192.	202.	199.	182.
159.	139.	122.	106.	93.	81.	71.	62.	54.	48.
42.	36.	32.	28.	24.	21.	19.	16.	14.	12.

D-14

	11.	10.	8.	7.	6.	6.	5.	4.	4.	3.
	3.	3.	2.	2.	2.					

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.42	22.19	2.23	54884.
										(620.)	(564.)	(57.)	(1554.14)

****

HYDROGRAPH ROUTING

ROUTE THRU STARK RES.

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1193.	-1

STAGE	1143.00	1144.80	1145.00	1146.00	1147.00	1148.00	1149.00
FLOW	0.00	54.00	221.00	520.00	895.00	1331.00	1822.00
SURFACE AREA=	0.	9.	25.				
CAPACITY=	0.	56.	123.				
ELEVATION=	1125.	1143.	1147.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1143.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1145.0	3.0	1.5	200.

PEAK OUTFLOW IS 219. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 502. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 757. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 1011. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 1266. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 25[illegible] AT TIME 41.75 HOURS

D-15

HYDROGRAPH ROUTING

ROUTE TO COVEY SWAMP

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.800	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0900	.0450	.0900	1102.0	1160.0	2200.	.06670

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1160.00 200.00 1120.00 305.00 1115.00 335.00 1102.00 345.00 1102.00
375.00 1115.00 450.00 1120.00 1200.00 1160.00

STORAGE	0.00	2.63	7.43	14.40	23.54	38.92	170.71	116.88	172.47	238.11
	318.93	408.93	510.11	622.46	745.99	880.70	1026.59	1183.65	1351.89	1531.31
OUTFLOW	0.00	718.50	2961.03	7210.25	13923.19	25526.54	43832.84	70843.66	107039.84	153294.17
	210509.18	279571.31	361346.28	456676.81	566383.35	691265.47	832103.35	989659.32	1164679.18	1357893.48
STAGE	1102.00	1105.05	1108.11	1111.16	1114.21	1117.26	1120.32	1123.37	1126.42	1129.47
	1132.53	1135.58	1138.63	1141.68	1144.74	1147.79	1150.84	1153.89	1156.95	1160.00
FLOW	0.00	718.50	2961.03	7210.25	13923.19	25526.54	43832.84	70843.66	107039.84	153294.17
	210509.18	279571.31	361346.28	456676.81	566383.35	691265.47	832103.35	989659.32	1164679.18	1357893.48

MAXIMUM STAGE IS 1102.9

MAXIMUM STAGE IS 1104.1

MAXIMUM STAGE IS 1105.1

MAXIMUM STAGE IS 1105.4

MAXIMUM STAGE IS 1105.8

MAXIMUM STAGE IS 1107.5

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUBAREA RUOFF TO COVEY SWAMP

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.45	0.00	2.57	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	118.00	127.00	136.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.25 CP= .62 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 28 END-OF-PERIOD ORDINATES. LAG= 1.24 HOURS. CP= .62 VOL= 1.00

12.	42.	83.	121.	143.	143.	123.	98.	79.	63.
51.	40.	32.	26.	21.	17.	13.	11.	9.	7.
5.	4.	4.	3.	2.	2.	1.	1.		

11-0

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.42	22.19	2.23	25527.
										(620.)	(564.)	(57.)	(722.84)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THRU COVEY SWAMP

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO

	6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1050.	-1

STAGE	1050.00	1052.10	1053.40	1054.80	1056.10	1057.40	1058.10	1059.40	1060.70	1062.00
FLOW	0.00	76.00	182.00	335.00	528.00	759.00	944.00	1286.00	1671.00	2101.00

SURFACE AREA=	0.	6.	25.
CAPACITY=	0.	19.	152.
ELEVATION=	1048.	1050.	1059.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1050.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1059.3	3.0	1.5	429.

PEAK OUTFLOW IS 271. AT TIME 43.25 HOURS

PEAK OUTFLOW IS 628. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 954. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 1319. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 1827. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 3729. AT TIME 41.50 HOURS

D-16

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE FLOW TO GLENWOOD

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0400	.0400	.0800	905.0	940.0	4300.	.07100

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 940.00 190.00 920.00 220.00 910.00 225.00 905.00 240.00 905.00
258.00 915.00 300.00 920.00 600.00 940.00

STORAGE	0.00	3.06	6.80	11.23	16.82	23.76	32.53	45.30	62.59	88.56
	116.78	156.85	203.60	259.36	323.33	395.80	475.89	564.87	661.27	766.87
OUTFLOW	0.00	409.79	1327.39	2734.82	4738.67	7305.60	10738.50	15268.89	20998.88	27789.08
	36595.78	47885.96	61952.39	79111.34	99666.22	123907.80	152115.46	184558.64	221498.88	263186.58
STAGE	905.00	906.04	908.68	910.53	912.37	914.21	916.05	917.89	919.74	921.58
	923.42	925.26	927.11	928.95	930.79	932.63	934.47	936.32	938.16	940.00
FLOW	0.00	409.79	1327.39	2734.82	4738.67	7305.60	10738.50	15268.89	20998.88	27789.08
	36595.78	47885.96	61952.39	79111.34	99666.22	123907.80	152115.46	184558.64	221498.88	263186.58

MAXIMUM STAGE IS 906.2

MAXIMUM STAGE IS 907.3

MAXIMUM STAGE IS 907.9

MAXIMUM STAGE IS 908.7

MAXIMUM STAGE IS 909.3

MAXIMUM STAGE IS 911.4

********** *********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUBAREA RUNOFF TO GLENWOOD

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
8	0	0	0	0	0	1	8	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.13	0.00	2.57	0.08	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	118.00	127.00	136.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .880

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.93 CP= .62 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 44 END-OF-PERIOD ORDINATES, LAG= 1.93 HOURS, CP= .62 VOL= 1.00

10.	38.	77.	121.	166.	203.	228.	238.	231.	207.
180.	157.	137.	119.	104.	90.	79.	68.	60.	52.
45.	39.	34.	30.	26.	23.	20.	17.	15.	13.
11.	10.	9.	8.	7.	6.	5.	4.	4.	3.
3.	2.	2.	2.						

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.42	22.19	2.23	62813.
										(620.)	(564.)	(57.)	(1778.67)

****

COMBINE HYDROGRAPHS

COMBINE HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
9	2	0	0	0	0	1	0	0

****

HYDROGRAPH ROUTING

ROUTE THRU GLENWOOD

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
10	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-755.	-1

STAGE	754.60	756.40	757.80	759.20	760.60	762.00	763.30	764.50	765.80	767.00
FLOW	0.00	74.00	233.00	450.00	719.00	1037.00	1370.00	1759.00	2209.00	2721.00
SURFACE AREA=	0.	10.	17.	40.						
CAPACITY=	0.	21.	91.	642.						
ELEVATION=	748.	755.	760.	780.						

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
754.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
759.2	0.0	0.0	0.

CREST LENGTH	0.	65.	162.	438.
AT OR BELOW ELEVATION	759.2	759.4	759.8	760.4

PEAK OUTFLOW IS 462. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 1135. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1754. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 2374. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 3272. AT TIME 41.75 HOLRS

PEAK OUTFLOW IS 6665. AT TIME 41.75 HOURS

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	1	.99	1	255.	510.	765.	1020.	1274.	2549.
		(2.56)	(	7.22)(	14.43)(	21.65)(	28.87)(	36.09)(	72.17)(
ROUTED TO	2	.99	1	219.	502.	757.	1011.	1266.	2534.
		(2.56)	(	6.20)(	14.21)(	21.43)(	28.62)(	35.85)(	71.76)(
ROUTED TO	3	.99	1	219.	502.	756.	1009.	1264.	2532.
		(2.56)	(	6.20)(	14.22)(	21.41)(	28.58)(	35.80)(	71.71)(
HYDROGRAPH AT	4	.45	1	147.	294.	440.	587.	734.	1468.
		(1.17)	(	4.16)(	8.31)(	12.47)(	16.63)(	20.78)(	41.57)(
2 COMBINED	5	1.44	1	316.	734.	1112.	1488.	1865.	3734.
		(3.73)	(	8.94)(	20.80)(	31.49)(	42.12)(	52.80)(	105.74)(
ROUTED TO	6	1.44	1	271.	620.	954.	1319.	1827.	3729.
		(3.73)	(	7.69)(	17.56)(	27.02)(	37.34)(	51.74)(	105.59)(
ROUTED TO	7	1.44	1	271.	620.	953.	1321.	1830.	3725.
		(3.73)	(	7.68)(	17.57)(	26.98)(	37.39)(	51.81)(	105.47)(
HYDROGRAPH AT	8	1.13	1	296.	592.	888.	1184.	1480.	2959.
		(2.93)	(	8.38)(	16.76)(	25.14)(	33.52)(	41.90)(	83.80)(
2 COMBINED	9	2.57	1	514.	1138.	1758.	2376.	3294.	6684.
		(6.66)	(	14.55)(	32.23)(	49.77)(	67.27)(	93.29)(	189.27)(
ROUTED TO	10	2.57	1	462.	1135.	1754.	2374.	3272.	6665.
		(6.66)	(	13.09)(	32.14)(	49.68)(	67.23)(	92.65)(	188.74)(

SUMMARY OF DAM SAFETY ANALYSIS

STARK RESERVOIR

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	1143.00	1143.00	1145.00
	STORAGE	56.	56.	82.
	OUTFLOW	0.	0.	221.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1144.99	0.00	82.	219.	0.00	42.50	0.00
.20	1145.41	.41	89.	502.	4.50	41.75	0.00
.30	1145.68	.68	94.	757.	6.25	41.75	0.00
.40	1145.91	.91	98.	1011.	7.25	41.75	0.00
.50	1146.11	1.11	102.	1266.	8.00	41.75	0.00
1.00	1146.96	1.96	122.	2534.	10.50	41.75	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	219.	1102.9	42.75
.20	502.	1104.1	42.00
.30	756.	1105.1	41.75
.40	1009.	1105.4	41.75
.50	1264.	1105.8	41.75
1.00	2532.	1107.5	41.75

SUMMARY OF DAM SAFETY ANALYSIS

COUEY - SWAMP

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1050.00	1050.00	1069.30
STORAGE	19.	19.	152.
OUTFLOW	0.	0.	1260.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1054.22	0.00	58.	271.	0.00	43.25	0.00
.20	1056.55	0.00	93.	620.	0.00	42.75	0.00
.30	1058.14	0.00	125.	954.	0.00	42.50	0.00
.40	1059.39	.09	154.	1319.	.75	42.50	0.00
.50	1059.78	.48	164.	1827.	2.50	41.75	0.00
1.00	1060.66	1.36	189.	3729.	5.25	41.50	0.00

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	271.	906.2	43.25
.20	620.	907.3	42.75
.30	953.	907.9	42.75
.40	1321.	908.7	42.50
.50	1830.	909.3	41.75
1.00	3725.	911.4	41.50

D-24

SUMMARY OF DAM SAFETY ANALYSIS

GLENWOOD LAKE

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	754.60	754.60	759.20
STORAGE	21.	21.	78.
OUTFLOW	0.	0.	450.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	759.26	.06	79.	462.	1.00	43.50	0.00
.20	760.30	1.10	96.	1135.	5.75	42.25	0.00
.30	760.67	1.47	102.	1754.	7.50	42.00	0.00
.40	760.96	1.76	107.	2374.	9.00	42.00	0.00
.50	761.32	2.12	113.	3272.	9.25	41.75	0.00
1.00	762.42	3.22	133.	6665.	10.50	41.75	0.00

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
```

1		A1	NATIONAL DAM INSPECTION PROGRAM								
2		A2	BREACH ANALYSIS								
3		A3	GLENWOOD LAKE PA0327								
4		B	100	0	15	0	0	0	0	0	-4	0
5		B1	5	0	0	0	0	0	0	0	0	0
6		J	3	2	1	0	0	0	0	0	0	0
7		J1	.2	.5	0	0	0	0	0	0	0	0
8		K	0	1	0	0	0	0	1	0	0	0
9		K1	INFLOW TO STARK RES.									
10		M	1	1	.99	0	2.57	0	0	0	1	0
11		P	0	21.5	118	127	136	142	0	0	0	0
12		T	0	0	0	0	0	0	1	.05	0	0
13		W	2	.62	0	0	0	0	0	0	0	0
14		X	-1.5	-.05	2	0	0	0	0	0	0	0
15		K	1	2	0	0	0	0	1	0	0	0
16		K1	ROUTE THRU STARK RES.									
17		Y	0	0	0	1	1	0	0	0	0	0
18		Y1	1	0	0	0	0	0	-1143	-1	0	0
19		Y4	1143	1144	1145	1146	1147	1148	1149	0	0	0
20		Y5	0	54	221	520	895	1331	1822	0	0	0
21		SA	0	9.4	25	0	0	0	0	0	0	0
22		SE	1125	1143	1147.0	0	0	0	0	0	0	0
23		SS	1143	0	0	0	0	0	0	0	0	0
24		SD	1145	3	1.5	200	0	0	0	0	0	0
25		K	1	3	0	0	0	0	1	0	0	0
26		K1	ROUTE TO COVEY SWAMP									
27		Y	0	0	0	1	1	0	0	0	0	0
28		Y1	1	0	0	0	0	0	0	0	0	0
29		Y6	.09	.045	.09	1102	1160	2200	.0667	0	0	0
30		Y7	0	1160	200	1120	305	1115	335	1102	345	1102
31		Y7	375	1115	450	1120	1200	1160	0	0	0	0
32		K	0	4	0	0	0	0	1	0	0	0
33		K1	SUBAREA RUOFF TO COVEY SWAMP									
34		M	1	1	.45	0	2.57	0	0	0	1	0
35		P	0	21.5	118	127	136	142	0	0	0	0
36		T	0	0	0	0	0	0	1	.05	0	0
37		W	1.25	.62	0	0	0	0	0	0	0	0
38		X	-1.5	-.05	2	0	0	0	0	0	0	0
39		K	2	5	0	0	0	0	1	0	0	0
40		K1	COMBINE HYDROGRAPHS									
41		K	1	6	0	0	0	0	1	0	0	0
42		K1	ROUTE THRU COVEY SWAMP									
43		Y	0	0	0	1	1	0	0	0	0	0
44		Y1	1	0	0	0	0	0	-1050	-1	0	0
45		Y4	1050	1052.1	1053.4	1054.8	1056.1	1057.4	1058.1	1059.4	1060.7	1062
46		Y5	0	75	182	335	528	794	944	1286	1691	2161
47		SA	0	5.8	25	0	0	0	0	0	0	0
48		SE	1040	1050	1059.3	0	0	0	0	0	0	0
49		SS	1050	0	0	0	0	0	0	0	0	0
50		SD	1059.3	3	1.5	424	0	0	0	0	0	0

```
51          K       1         7         0         0         0         0         1         0         0         0
52          K1      ROUTE FLOW TO GLENWOOD
53          Y       0         2         0         1         1         0         0         0         0         0
54          Y1      1         0         0         0         0         0         0         0         0         0
55          Y6    .08       .04       .08       905       940      4300      .071         0         0         0
56          Y7      0       940       190       920       220       910       225       905       240       905
57          Y7    250       915       300       920       600       940         0         0         0         0
58          K       0         8         0         0         0         0         1         0         0         0
59          K1      SUBAREA RUNOFF TO GLENWOOD
60          P       1         1      1.13         0      2.57         0         0         0         1         0
61          P       0      21.5       118       127       136       142         0         0         0         0
62          I       0         0         0         0         0         0         1      .05         0         0
63          W    1.93       .62         0         0         0         0         0         0         0         0
64          X    -1.5      -.05         2         0         0         0         0         0         0         0
65          K       2         9         0         0         0         0         1         0         0         0
66          K1      COMBINE HYDROGRAPHS
67          K       1        10         0         0         0         0         1         0         0         0
68          K1      ROUTE THRU GLENWOOD
69          Y       0         0         0         1         1         0         0         0         0         0
70          Y1      1         0         0         0         0         0         0         0         0         0
71          Y4  754.6     756.4     757.8     759.2     760.6       762     763.3     764.5     765.8       767
72          Y5      0        74       233       450       719      1037      1370      1759      2209      2721
73          SA      0       9.6      16.5      40.4         0         0         0         0         0         0
74          SE    748     754.6       760       780         0         0         0         0         0         0
75          SS  754.6         0         0         0         0         0         0         0         0         0
76          SD  759.2         0         0         0         0         0         0         0         0         0
77          SL      0        65       162       438         0         0         0         0         0         0
78          SV  759.2     759.4     759.8     760.4         0         0         0         0         0         0
79          SB     20         1       752       .25       750     760.2         0         0         0         0
80          SB     40         1       752       .25       750     760.2         0         0         0         0
81          SB     60         1       752       .25       750     760.2         0         0         0         0
82          K      99         0         0         0         0         0         0         0         0         0
```

SUMMARY OF DAM SAFETY ANALYSIS
STARK RESERVOIR

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1143.00	1143.00	1145.00
STORAGE	56.	56.	82.
OUTFLOW	0.	0.	221.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1145.41	.41	89.	502.	4.50	41.75	0.00
.50	1146.11	1.11	102.	1266.	8.00	41.75	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1143.00	1143.00	1145.00
STORAGE	56.	56.	82.
OUTFLOW	0.	0.	221.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1145.41	.41	89.	502.	4.50	41.75	0.00
.50	1146.11	1.11	102.	1266.	8.00	41.75	0.00

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1143.00	1143.00	1145.00
STORAGE	56.	56.	82.
OUTFLOW	0.	0.	221.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1145.41	.41	89.	502.	4.50	41.75	0.00
.50	1146.11	1.11	102.	1266.	8.00	41.75	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	502.	1104.1	42.00
.50	1264.	1105.8	41.75

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	502.	1104.1	42.00

.50	1264.	1105.8	41.75

PLAN 3 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	502.	1104.1	42.00
.50	1264.	1105.8	41.75

SUMMARY OF DAM SAFETY ANALYSIS

Covey Swamp

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1050.00	1050.00	1059.30
STORAGE	19.	19.	152.
OUTFLOW	0.	0.	1260.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1056.55	0.00	93.	620.	0.00	42.75	0.00
.50	1059.78	.48	164.	1827.	2.50	41.75	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1050.00	1050.00	1059.30
STORAGE	19.	19.	152.
OUTFLOW	0.	0.	1260.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1056.55	0.00	93.	620.	0.00	42.75	0.00
.50	1059.78	.48	164.	1827.	2.50	41.75	0.00

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1050.00	1050.00	1059.30
STORAGE	19.	19.	152.
OUTFLOW	0.	0.	1260.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1056.55	0.00	93.	620.	0.00	42.75	0.00
.50	1059.78	.48	164.	1827.	2.50	41.75	0.00

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	620.	907.3	42.75
.50	1830.	909.3	41.75

PLAN 2 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	620.	907.3	42.75

62-D

.50	1830.	909.3	41.75

PLAN 3 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	620.	907.3	42.75
.50	1830.	909.3	41.75

SUMMARY OF DAM SAFETY ANALYSIS
GLENWOOD DAM

PLAN 1 ..20' BREACH..

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	750.00	754.60	759.20
STORAGE	1.	20.	76.
OUTFLOW	0.	0.	450.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	760.27	1.07	93.	2370.	1.61	42.00	41.75
.50	760.47	1.27	97.	3263.	5.00	42.00	39.75

PLAN 2 ..40' BREACH..

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	750.00	754.60	759.20
STORAGE	1.	20.	76.
OUTFLOW	0.	0.	450.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	760.27	1.07	93.	3324.	1.52	42.00	41.75
.50	760.36	1.16	95.	3525.	1.79	40.00	39.75

PLAN 3 ..60' BREACH..

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	750.00	754.60	759.20
STORAGE	1.	20.	76.
OUTFLOW	0.	0.	450.

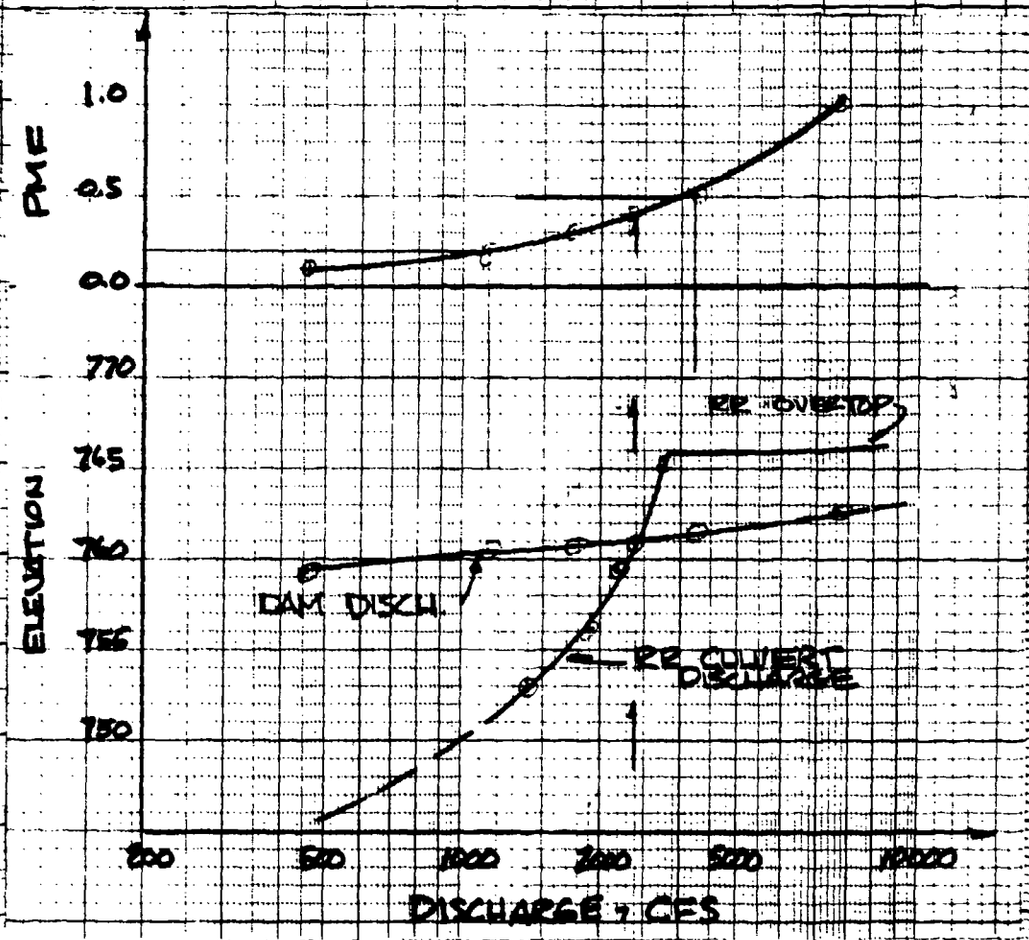
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	760.27	1.07	93.	4148.	1.49	42.00	41.75
.50	760.36	1.16	95.	4391.	1.25	40.00	39.75

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB NDI - Pa.
SHEET NO ____ OF ____
CALCULATED BY SJMa DATE 6/81
CHECKED BY ____ DATE ____
SCALE ____

EVALUATE HEC-1DB ANALYSES WITH RESPECT TO DOWNSTREAM CONDITIONS.

1. FLOOD FLOWS GREATER THAN ± 0.4 PMF WILL CAUSE SUBMERGENCE OF THE DAM BY BACKWATER FROM THE R.R. EMBANKMENT



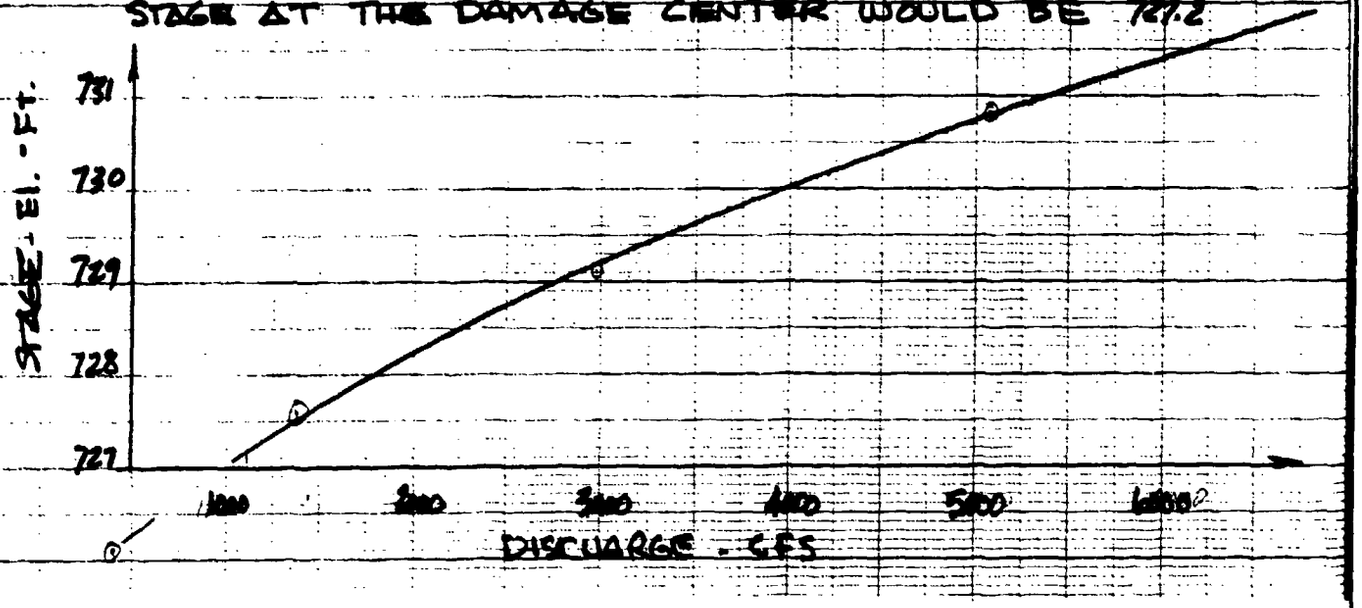
2. THE FOLLOWING COMMENTS / ANALYSES ASSUME:
   (a) THE STORAGE AVAILABLE BETWEEN THE DAM AND THE R.R. EMB. IS INSIGNIFICANT
   (b) THE R.R EMBANKMENT CAN WITHSTAND THE LOADS APPLIED BY THE DAM BREAK (note: the RR Emb. will overtop at flows > 0.5 PMF

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB NDI - 124
SHEET NO ____ OF ____
CALCULATED BY [signature] DATE 6/81
CHECKED BY ____ DATE ____
SCALE ____

OVERTOPPING FAILURE BEGINS AT RESV. ELEVATIONS OF APPROX. 760.3

DISCHARGE AT THIS ELEV. IS 1135 cfs
ASSUMING INSIGNIFICANT ROUTING EFFECTS DOWNSTR'M
THE CULVERT HEADWATER ELEVATION WOULD BE 761±
STAGE AT THE DAMAGE CENTER WOULD BE 727.2



PEAK DISCHARGE FROM DAM BREACH = 4148 cfs (0.2 PMF)
= 4391 cfs (0.5 PMF)

AN EL. OF 766± IS REQUIRED TO PASS THE PEAK BREACH FLOWS AT THE RR. CULVERT WHICH IS WELL ABOVE THE PEAK RESV. STAGE OF 760.3. THEREFOR HYDRAULIC CONTROL SHIFTS FROM THE DAM TO THE RR EMB. CAUSING BACKWATER FROM THE EMB. TO SUBMERGE THE BREACH. FOR AN ESTIMATE OF DAMAGE DOWNSTREAM ASSUME THE FLOW VOLUME FROM THE BREAK IS SUFFICIENT TO CAUSE THE BACKWATER PEAK TO BE NEAR THE PEAK RESERVOIR STAGE @ EL. 760±
AT EL. 760 THE CULVERT DISCHARGE IS 2330± cfs
A DISCHARGE OF 2330 cfs CAUSES A STAGE OF El. 728.6 AT THE DAMAGE CENTER OR A RISE IN WATERSURFACE OF +1.6 FEET

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB NDI - PA
SHEET NO ____ OF ____
CALCULATED BY ____ DATE 6/81
CHECKED BY ____ DATE ____
SCALE ____

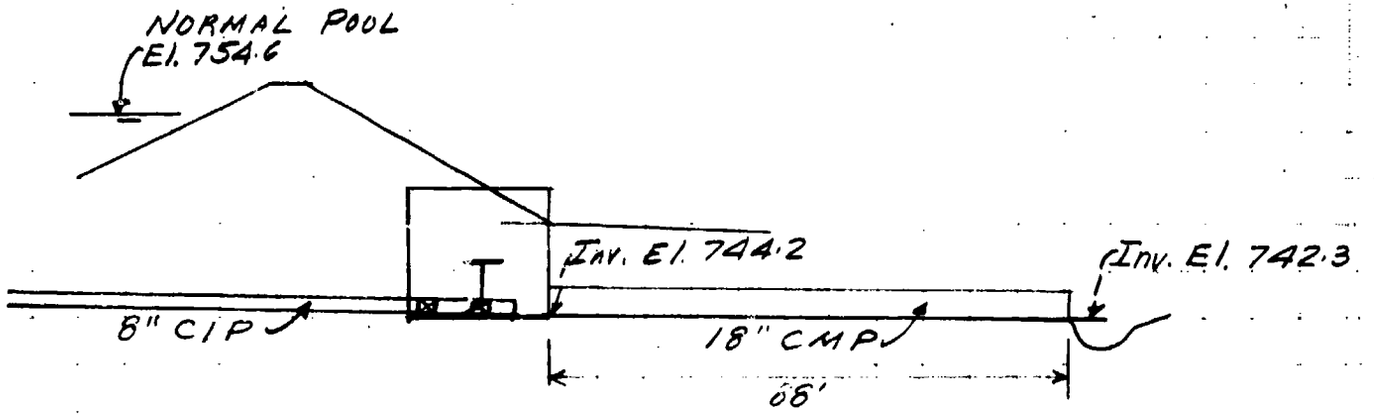
IN THE EVENT THAT THE RR EMB. WAS BREACHED PRIOR TO THE DAM BREAK (either by previous storm flow or abandonment of the trackage)

THE RESULTING STAGE INCREASE AT THE DAMAGE CENTER WOULD BE = 730.3
- 727.1
Δ STAGE = + 3.2'

FAILURE OF THE RR EMBANKMENT BY OVERTOPPING WOULD BE A MUCH MORE SEVERE CASE. RESTRICTION OF THE R.R. CULVERT BY DEBRIS FROM A FLOODWOOD BREACH COULD CAUSE THE RR EMBANKMENT TO OVERTOP AND SUBSEQUENTLY TO FAIL.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

OUTLET WORKS



Assume inlet control for the 18"ϕ CMP

HW/D	H	Q*	W.S. ELEVATION (ft) AT INLET	W.S. ELEVATION (ft) RESERVOIR	h	$q_{8"CIP} = C_3 \sqrt{2g}\, a\sqrt{h}$
1	1.50	6.5	745.70	↑	8.9	5 cfs
1.25	1.88	8.5	746.08	754.6	8.52	4.92
1.50	2.25	10.0	746.45	↓	8.15	4.80

Where H and h are the head on the 18" and 8" pipes, respectively
Q and q are the respective discharges; a = area in ft²

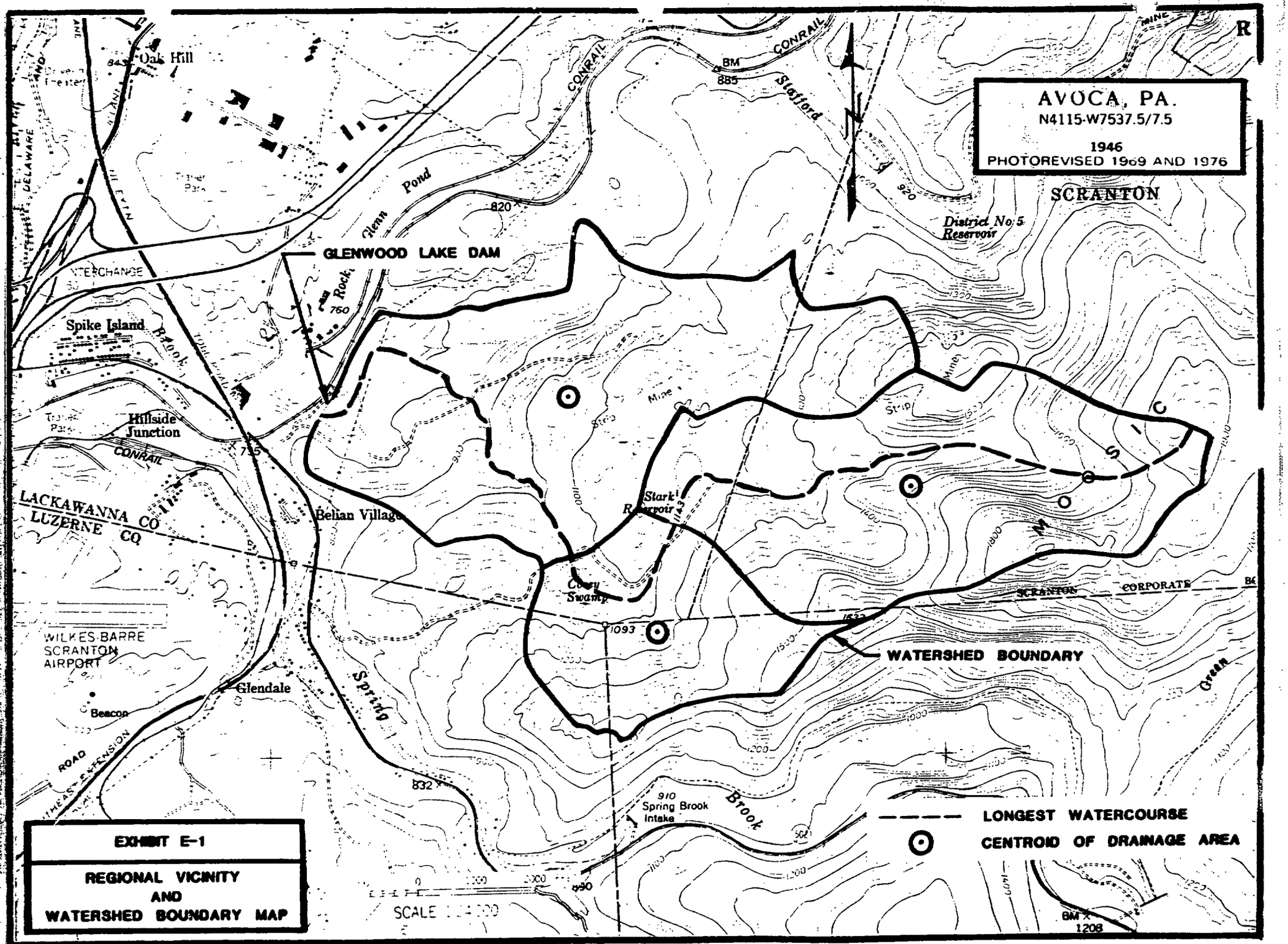
For 5 cfs HW/D = 0.85; H = 1.28
W.S. Elev. at Inlet to 18"ϕ CMP is 744.2 + 1.28 = 745.48'
h = 754.6 − 745.48 = 9.12 $q = C\, a \sqrt{2g}\sqrt{h}$

for C = 0.6 ; a = 0.35 ft² q = 5.09 cfs, say 5 cfs

* From Hyd. Circular No. 5, USBPR, 1965

APPENDIX E

EXHIBITS


AVOCA, PA.
N4115-W7537.5/7.5
1946
PHOTOREVISED 1969 AND 1976
SCRANTON
GLENWOOD LAKE DAM
Oak Hill
Spike Island
Hillside Junction
Belian Village
Glenn Pond
Rock
District No. 5 Reservoir
Stark Reservoir
Coxy Swamp
Spring Brook Intake
Glendale
WILKES-BARRE SCRANTON AIRPORT
Beacon
LACKAWANNA CO
LUZERNE CO
CONRAIL
Stafford
Strip Mine
SCRANTON CORPORATE
WATERSHED BOUNDARY
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
EXHIBIT E-1
REGIONAL VICINITY AND WATERSHED BOUNDARY MAP

APPENDIX F

GEOLOGY

GLENWOOD LAKE DAM

APPENDIX F

GEOLOGY

The Glenwood Lake Dam and reservoir area are located on the eastern edge of the Northern Anthracite Field of the Ridge and Valley Physiographic Province. Deposits of glacial drift of variable thickness cover the entire area. The drift was deposited by the Wisconsin Ice Sheet during the Pleistocene period of geologic time.

The glacial drift is composed primarily of till which is a reddish brown, unsorted, compact mixture of clay, silt, sand, gravel, and cobbles with occasional boulder size pieces. The stone pieces are sub-angular to rounded and consist mainly of sandstone and siltstone derived from the Catskill Formation, the dominant rock formation surrounding the coal field on the north, east and west. The clay content and compact nature of the till makes it a relatively impervious soil type.

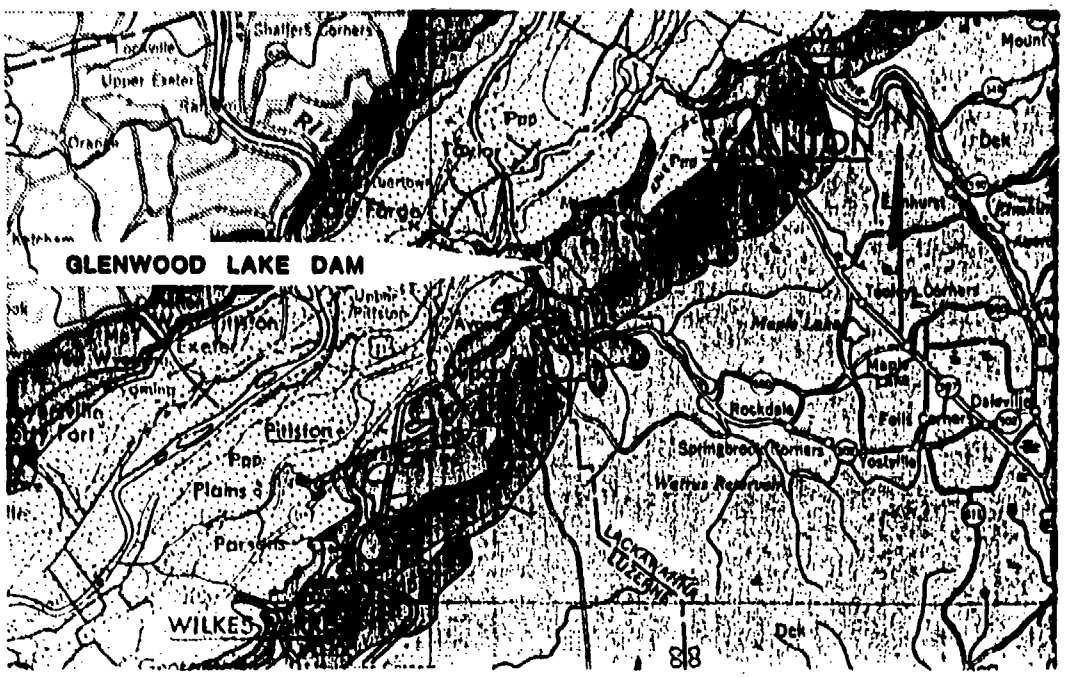
Some deposits of glacial outwash, moraines and Kame terraces are also found in the area. These deposits are composed of loose, poorly sorted to stratified deposits of silt, sand and gravel. The Kame and outwash deposits are generally very pervious and variable in thickness. In some areas, glacial scouring has resulted in buried valleys filled with glacial sediments.

Other loose pervious soils in the area are the recent deposits of alluvial silt, sand, and gravel with some clay. These soils are localized and limited to streambeds and flood plain areas. The flat, marshy area northeast of the lake contains such alluvial deposits.

The bedrock underlying the entire dam and reservoir area is the Pottsville Formation of the Pennsylvanian age. The Pottsville strata generally consists of gray sandstone and conglomerate with a few thin coal seam and some gray and brown shale and siltstone layers. The conglomeratic layers are the dominant lithology and exposures of this rock type are located on the left abutment and in the spillway channel (strike N 10°E, Dip 5° SW). Underlying the Pottsville Formation is the Post-Pottsville Formation which contains many thick mineable coal seams.

The major structural feature of the area is the Wyoming Syncline. The Syncline strikes N 50° E and dips range from 0 - 40°. The dam and reservoir site are located on the eastern limb of this syncline.

Ref.: Ground Water of Northeastern Pennsylvania, Stanley W. Lehman, 1937; Bulletin W-4, Pennsylvania Geologic Survey.



0 1 2 3 4 5 10 MILES

SCALE: 1" = 4 MILES

LEGEND

PENNSYLVANIAN

ANTHRACITE REGION

Pop — **Post-Pottsville Formations**
Brown or gray sandstones and shales with some conglomerate and numerous minable coals.

Pottsville Group
Light gray to white, coarse grained sandstones and conglomerates with some minable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Mmc — **Mauch Chunk Formation**
Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties, Loyalhanna Limestone at the base in southwestern Pennsylvania.

Pocono Group
Predominantly gray, hard, massive, cross bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations, includes part of "Chemung" of M L Fuller in Potter and Tioga counties

DEVONIAN

UPPER

CENTRAL AND EASTERN PENNSYLVANIA

Dos — **Oswayo Formation**
Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved.

Dck — **Catskill Formation**
Chiefly red to brownish shales and sandstones, includes gray and greenish sandstone tongues named Elk Mountain Honesdale, Shohola, and Delaware River in the east

Dm — **Marine beds**
Gray to olive brown shales, graywackes, and sandstones, contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock. Tully Limestone at base

Ds — **Susquehanna Group**
Barbed line is "Chemung-Catskill" contact of second Pennsylvania Survey County reports, barbs on "Chemung" side of line

NOTE:
GEOLOGIC MAP AND LEGEND OBTAINED FROM GEOLOGIC MAP OF PENNSYLVANIA BY PA. TOPOGRAPHIC AND GEOLOGIC SURVEY, DATED 1980

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

GLENWOOD LAKE DAM
GEOLOGIC MAP

GEO - Technical Services, Inc.
HARRISBURG, PA

JUNE, 1981

EXHIBIT F